THERMOTRON

A Venturedyne, Ltd., Company

WinVCS
Instruction Manual

*Software Installation/Operation/Programming/ Calibration
/Hardware Interface Description & Installation*

WinVCS Version 1.31

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How to Use This Manual

This manual is set up to provide you the information that you need in a logical format. Each section or appendix is described below along with its purpose:

- The Safety Instructions provide you with instructions for safe operation of the VCS.

- The Specifications list the VCS hardware specifications.

- Section 1 provides the software installation and start-up procedure, and it provides an overview of the hardware and software systems.

- Section 2 provides the basic operating procedures for WinVCS. This includes all operating procedures except for test definition, global internal settings, and calibration verification.

- Sections 3, 4, and 5 provide the test definition procedures for the Random, Sine, and Shock vibration modes. Each section also describes the graphic displays for its particular mode.

- Section 6 provides the operating procedures for the global internal settings and calibration verification.

- Section 7 provides all the VCS hardware information, including the descriptions and installation procedures.

- The Appendices provide you with the software system capabilities, list of acronyms, terms, and definitions.

Electromagnetic Compatibility Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at the user's expense.

Table of Contents

Safety Instructions

For the safe operation of this machine, read and understand all warnings and cautions.

WARNING: If you do not follow the instruction in a WARNING, injury can occur to you or to other personnel.

CAUTION: If you do not follow the instruction in a CAUTION, damage can occur to the equipment.

1. You must be trained to operate this equipment before using it.

2. Do not operate the VCS unless the system is completely assembled.

3. Maintenance and repairs must be done by authorized personnel only.

4. Make calibrations according to the specifications given in this manual.

5. Always use an electrical supply system with a separate electrical ground conductor.

6. Use the electrical power supply specified for this instrument. Using the wrong power supply can void certain parts of the warranty.

7. To prevent damage to the instrument, do not connect AC power to the terminal blocks.

8. Use only three-prong line cord receptacles on the rear of the instrument.

Static-Sensitive Device Caution Statement

CAUTION: The VCS contains components that are sensitive to electrostatic charges. When you are working around the VCS components, make sure you provide a static-safe work environment.

- When you work with the VCS components at the shaker, make sure you use a portable static-dissipative field service kit that provides a work mat and wrist strap with ground cords. Follow all instructions for proper use of the static protection equipment.

- Transport any replacement components in static shielding bags or containers.

- When you remove a faulty component from the VCS, store it immediately in a static-shielding bag or container.

The grounding procedures described above can effectively remove static from conductive objects such as your body or tools. However, you must also keep non-conductive objects, such as synthetic clothing, coffee cups, and vinyl or plastic products as far away from the static-sensitive components as possible.

Specifications

NOTE: See Appendix A: Vibration Mode Features and Techniques for more information on the
         Random, Sine, and Shock Vibration Modes.

PC Requirements   486 or above (Pentium Recommended)
                                       16Mbytes of RAM
                                       Digital Signal Processor Card

Input Channels

Number of Channels: 1 to 8 Monitor or Control Channels.

Input Impedance: 200KΩ

Dynamic Range: 80dB

Accuracy: ±1dB

Maximum Input Signal: 3 Volts peak

ICP Power: 4mA (28V maximum drive)

Coupling: ac (.1 Hz bottom corner)

Over Voltage Protection: 120Vac, 5,000V peak spike

Output Drive

Voltage: 20V peak-to-peak

Current: 20mA max current

Dynamic Range: 80dB

D/A Converter: 16 bit D/A converter

Test Scheduling   Sine, shock, and random tests can be scheduled.

Transducer Sensitivity Scaling   User programmed to desired level. Each input has calibration
                                       factor for calibrated accelerometers. Range of 1 to 1000 mV/g
                                       (1 to 102 mV/m/s^2).

Mechanical Specifications (I/O Module)

Dimensions: 2.5 inches high x 19 inches wide x 20 inches deep. You can
                                       mount it on a 19-inch rack.

Weight: 10 lb.

I/O Module Electrical Power Requirements

Power: 115 Vac ±10% at .25 A.
                                       230 Vac ±10% at .12 A.
                                       50 or 60 Hz operation.

Dissipation: 25 Watts

Ambient Operation Specifications

Temperature: 5°C to 50°C (40°F to 120°F)

Humidity: Non-condensing

Section 1
Getting Started

1. Overview

This section introduces you to the Vibration Control System (VCS) and the WinVCS software application. First, it provides a definition of VCS. Second, it provides the software installation and start-up procedure. Third, it provides a system description of the VCS hardware. Finally, it introduces you to the WinVCS software windows and displays.

1.1. Introduction

The Vibration Control System (VCS) is a PC-based instrument that drives, controls, and acquires data from an Electrodynamic Vibration Testing System, otherwise known as a shaker. It consists of an Input/Output module (I/O module), a personal computer with a Digital Signal Processor board (DSP), the Windows '95 operating system, and the WinVCS software package. The VCS provides the following functions and features:

- Test definition for Random, Sine, and Shock vibration testing, along with several specialized definitions.

- Test scheduling for multiple tests.

- Drive signal output to the shaker amplifier for the defined test or tests.

- Eight accelerometer inputs provide acceleration readings for vibration monitoring and closed-loop control of the shaker output.

- Frequency-domain graphs of the accelerometer response readings, drive signals to the shaker, and transmissibility readings between inputs.

- Records, stored test data, and drive signals for historical files.

- Remote Stop, Start, and Test Schedule inputs.

The WinVCS program provides frequency-domain test definitions and displays for Random, Sine, and Shock mode testing. The program works with the DSP card to convert time-domain inputs from the shaker to frequency-domain data. The program performs the conversions using the Fast Fourier Transform (FFT) model with a fixed Hann window. The user programs and examines all data in the frequency domain. The VCS program develops a frequency-domain drive profile to operate the shaker output. WinVCS works with the DSP card to convert the drive profile to a time-domain drive signal output to the I/O module.

The I/O module provides the electronic interface with the shaker and remote control systems. Eight accelerometer-input channels provide the readings from the accelerometers on the shaker and product load. The I/O module provides the power amplification and signal inputs to the computer's DSP card. It receives the drive signal from the DSP card, amplifies the signal, and applies the drive signal to the shaker's amplifier. The I/O module's remote inputs allow the user to operate the VCS and select a WinVCS test schedule for test control from a remote device.

1.2. Installing and Starting the WinVCS Program

CAUTION: When you start WinVCS, set the shaker amplifier to a gain of zero (0). The I/O module can develop voltage spikes during start-up that can damage the amplifier. Once WinVCS displays its main window, set the amplifier's gain to the desired level.

Follow this procedure to install and run the WinVCS program:

1. Make sure the VCS is fully installed according to the procedures in Section 7.

2. Install the WinVCS application 3.5" disk into the computer's disk drive.

3. Select Run from the Windows '95 Start menu to open the Run dialog box.

4. Type in a:\setup.exe, and click the **OK** button.
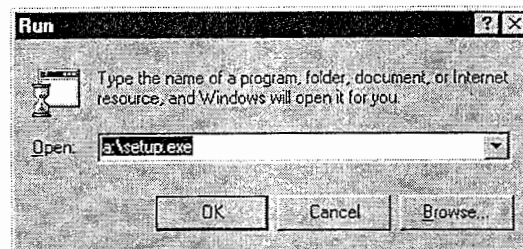
    a.   The Setup program starts and builds a standard Install Shield.

    b.   Next, the Setup program displays the following window:

    c.   Follow the instructions through the installation wizard to install the software. During installation, you can install the program in a different folder or drive than the default location.

5. Once you install the program, you can run it from its icon on the desk top or from the Start Menu:

    a.   To run the program from the desktop, double-click the WinVCS icon.

    b.   To run the program menu, select Start, Program Files, WinVCS, and WinVCS.

    c.   Either selection starts the WinVCS program. The WinVCS program opens the WinVCS Window to provide access to the program.
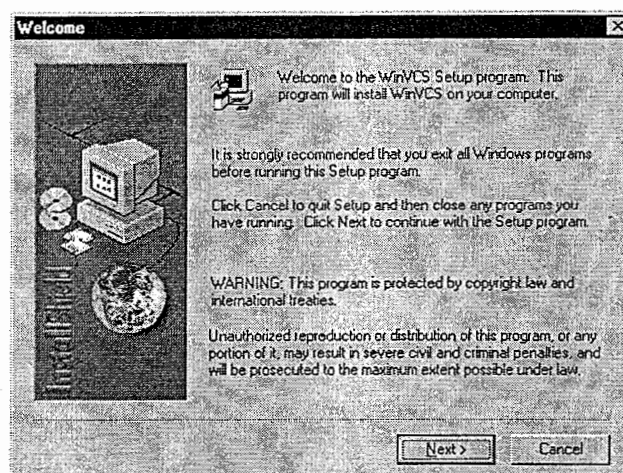
1.3. A Basic View of the VCS Interface

The VCS interface consists of the VCS computer with its DSP card and the I/O module. See Figure 1-1. These instruments combine to provide the closed-loop control and signal conversion for a shaker.

The VCS computer contains the WinVCS program in its hard drive, and it has the DSP card installed in its chassis. It runs the WinVCS software application that programs and operates the system. It uses the DSP card for signal conversions. All the data outside the VCS computer consists of time-domain information from the shaker accelerometers or drive signals to the shaker. The VCS computer uses the DSP card as the conversion interface between the time-domain signals and the WinVCS program's frequency-domain displays. In addition, the VCS computer provides the hard copy interface for plotters, printers, and other devices.

The I/O module provides the electronic interface between the VCS computer and the shaker.

- Eight input channels can provide accelerometer power and read the accelerometer inputs from the shaker and product.

- Two internal analog-to-digital converters digitize the accelerometer signals before sending them to the VCS computer.

- WinVCS communicates with the I/O module using COM 1 or COM 2. (The mouse may be connected to COM 1.) The COM port connects to the I/O module's Master connector.

- Two RS-422 ports communicate with the DSP card at the VCS computer to send digitized data and control signals to the computer, and to receive the drive output signal from the VCS computer.

- The drive output provides the drive signal to the shaker amplifier. The amplifier applies this signal to its power supplies to develop the waveforms that are applied to the shaker armature.

- The external-control terminal block and the front panel controls send signals to the I/O module for conversion to commands. The commands enter the VCS computer through an RS-232 port.

Together, the VCS instruments provide closed-loop programming and control of the shaker operations and provide remote control capabilities. See Section 7 for a detailed description and installation procedure for the VCS instruments.
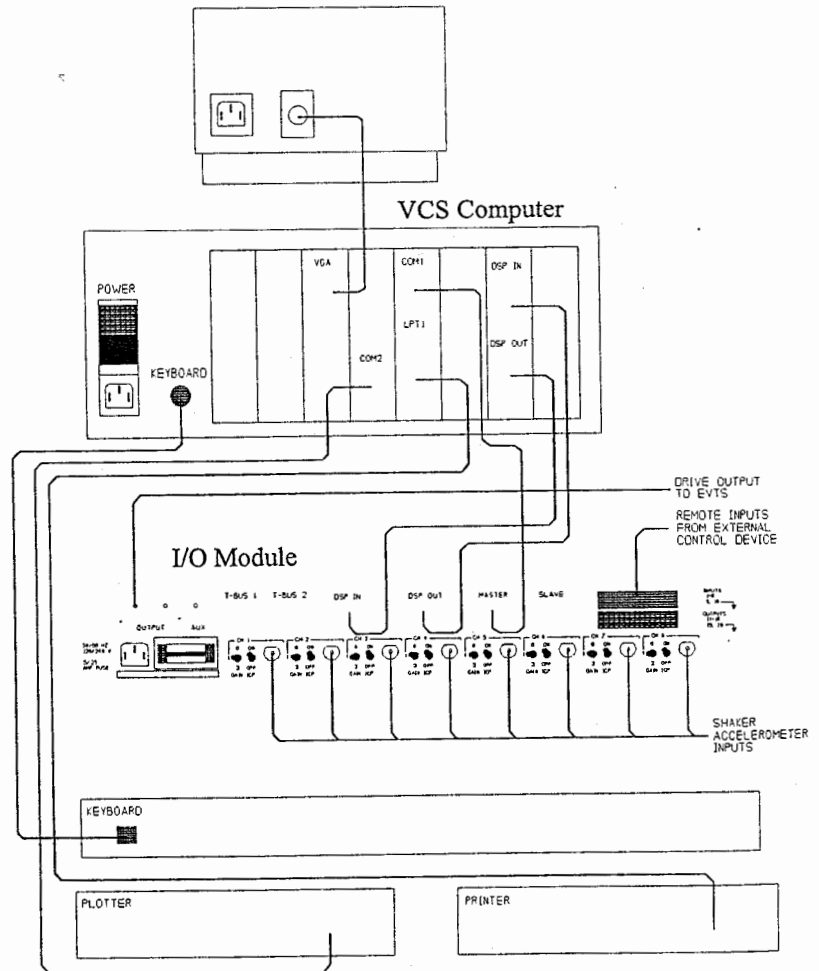
Figure 1-1. Vibration Control System Interface.

1.4. Taking a Short Tour through the WinVCS Program

WinVCS provides a full-featured vibration software package from a single control panel. It uses many of the available Windows '95 software tools to provide easy access to the program's commands and functions. The WinVCS windows divide the program into the following functions:

- The WinVCS window provides a control panel to operate many of the operational and display functions from one display. It also provides access to the more complex functions through its menu bar commands.

- The Graph Properties windows provide the scale and color controls for the graphs, and they provide the auto save and hard copy selections for the graphs.

- The Test Definition and Test Option window provide the parameter fields and tables needed to define and edit the vibration tests.

- The Test Schedule window allows the user to group defined tests into schedules that are available for selection at the VCS computer or form an external input at the I/O module.

- The General Options window provides access to the hardware settings and controls that affect the system operations and the limit displays.

- The Calibration command windows provide the controls needed to calibrate and verify the system electronics interface with the shaker.

The following topics introduce each of the windows, and they refer the user to the appropriate section of this manual for detailed information.

1.4.1. The WinVCS Window

The WinVCS window provides a control panel display of the current vibration mode and the general system tools. See Figure 1-2. It contains the only menu bar and tool bars in the software package to reduce the layers of functions for simplicity. The following description provides a short description of the WinVCS window.

The menu bar provides nine pull-down menus that provide access to the WinVCS commands and functions:

File	Provides access to the vibration tests and the test definition functions. It also lists several Windows '95 file management and printing commands.
Edit	Used to copy graphs to the clipboard.
View	Allows the user to control all of the tool bar, panel, and graphic displays configurations on the WinVCS window.
Graph	Allows the user to select and scale the graphs to be displayed in the graphic area. It also provides access to the auto save, auto hard copy and other functions for the graphs.
Options	Provide the test editing, test-scheduling, mode, and global options for the WinVCS program.
Command	Lists the operational commands that are displayed on the control panel. It also displays the External Input function used in Random Vibration mode.
Stored Data	Provides access to the data recording and storage functions for each vibration mode.
Calibration	Provides access to all the calibration and verification windows.

Help   Provides access to the WinVCS help system.

The toolbars, located below the menu bar, provide access to the most common commands with the click of a mouse button. See the tables at the beginning of Section 2 for a description of the menu bar commands and their buttons.

The WinVCS panels display the operational controls and status of the system as it runs a test.

The graphic displays are interactive charts of the different signal measurements. See Section 2 for a detailed explanation of the graphs and their features. See Sections 3 through 6 for a description of the graphs that are displayed by the different vibration modes.
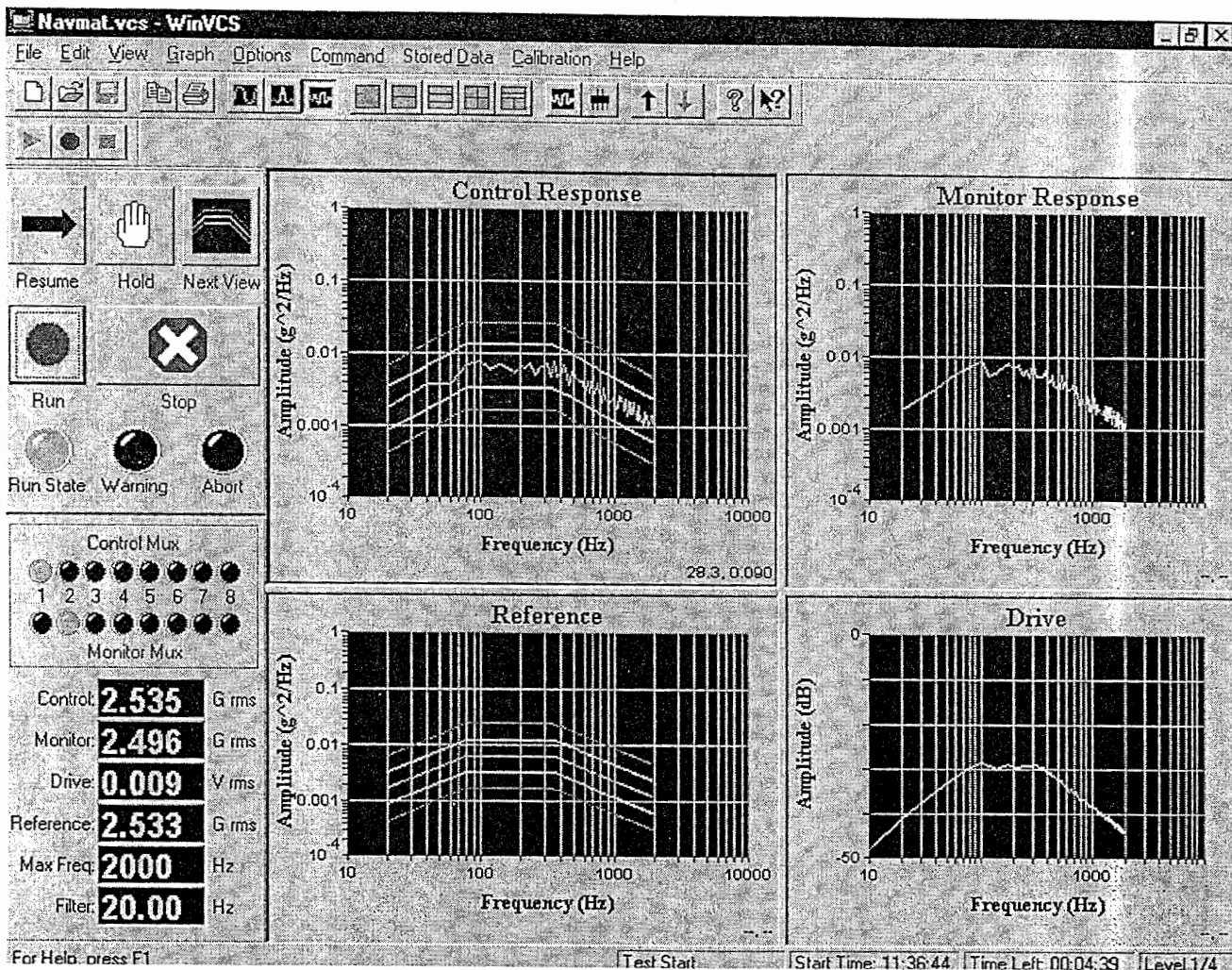
Figure 1-2. WinVCS Window.

1.4.2. Graphing Properties Window

The Graphing Properties window allows you to set up the parameters that affect the graphic displays. To display the Graphing Properties window, select the Properties command from the Graph menu. Figure 1-3 shows the Random Control System Graphing Properties window. Each vibration mode's Graphing Properties window displays an Options tab and a tab for each type of graph.

- The Options tab displays provide the user selections for the hard copy and auto save functions. It also provides an energy selection for the response displays.

- Each graph's tab displays the scale, axis limit, and graph color selections.

The user can also select the Graph Properties window by right-clicking a graph and selecting Properties from the pull-down list. The window opens with an Options tab and the tab for the selected graph. See Section 2 to operate the Graphing Properties window.
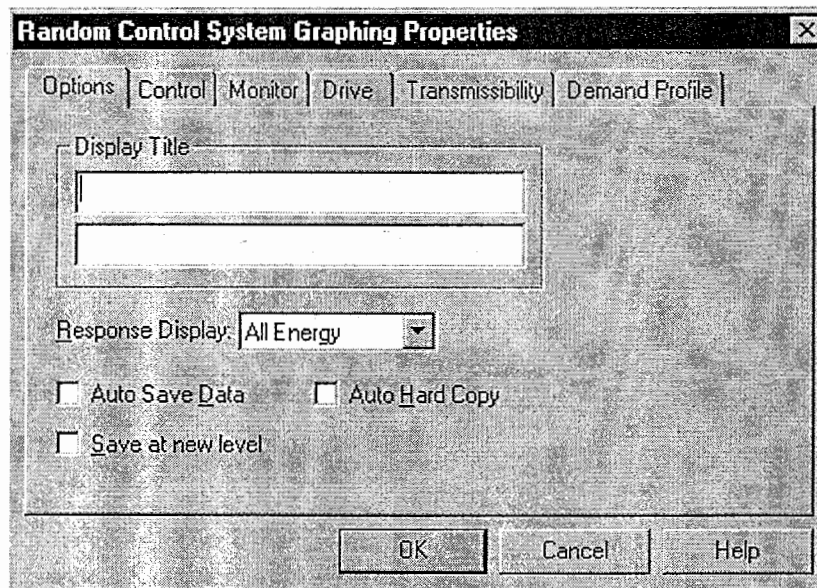
Figure 1-3. Graphing Properties Window.

1.4.3. Test Definition Windows

The Test Definition windows display all the parameter fields and tables required to define a vibration test. There are two methods to display the Test Definition windows:

- To define a new test, select New Test from the File menu. WinVCS displays each parameter screen for the vibration mode (Random, Sine, or Shock) sequentially as a Test Definition wizard.

- To edit the test displayed on the WinVCS widow, select Test Options from the Options menu. WinVCS displays the Properties window for the vibration mode. Figure 1-4 shows the Random Control System Properties window. The window provides tabbed access to the same displays that are used by the Test Definition wizard.

The Test Definition windows appear in several locations throughout the manual:

- Section 2 describes how to access the test options.

- Sections 3, 4 and 5 provide detailed test definition and editing procedures for each vibration mode.
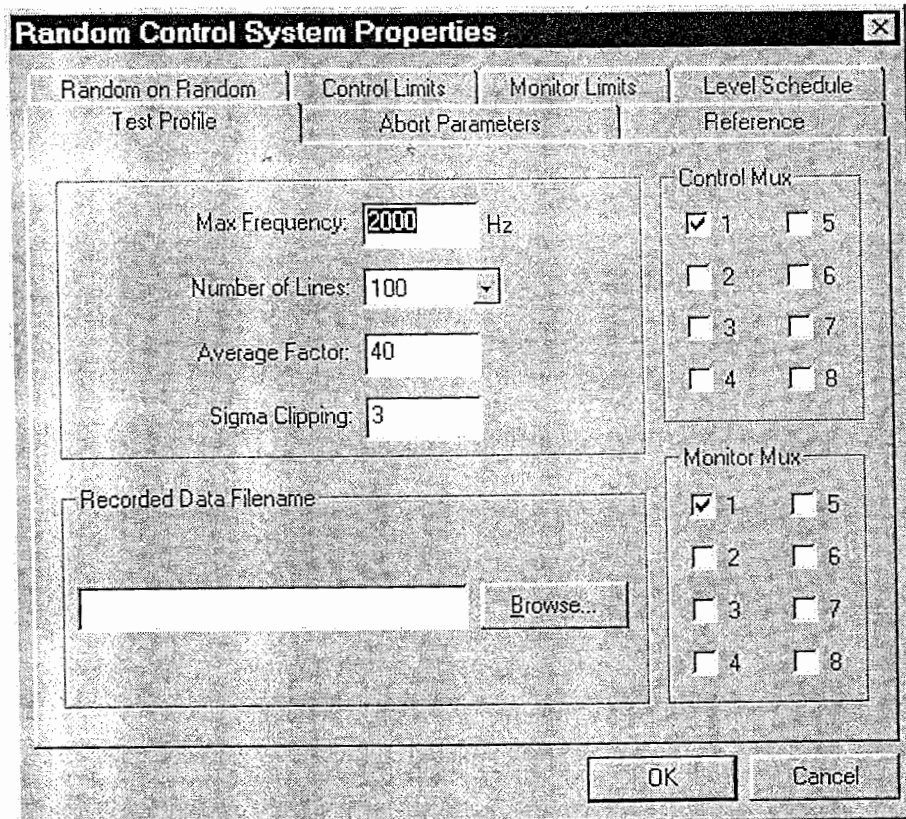
Figure 1-4. Random Control System Properties Window.

1.4.4. Test Schedule Windows

The Test Schedule windows allow you to assign multiple vibration tests to selectable tables called schedules. Figure 1-5 shows the Test Schedule window with two pre-defined tests loaded into a schedule. Tests can be defined from the three different vibration modes. The user assigns the tests to a schedule, and saves it as a test schedule (.sch) file. The user can build as many test schedules as desired. Up to seven schedules can be assigned for remote operation using the Remote Schedule Index window. See Figure 1-6. Select the Schedule Index button on the Test Schedule window to open the Remote Schedule Index. This window allows the test schedules to be assigned using the Remote Access bits from the remote terminal on the I/O module.

Test Schedule – C:\Program Files\WinVCS\testing.sch	⊠

New Schedule	Open...	Save As...	Schedule Index...

#	Test Filename
1	C:\Program Files\WinVCS\Flat.vcs
2	C:\Program Files\WinVCS\NavMat.vcs
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	

Browse...

Run Schedule   Close
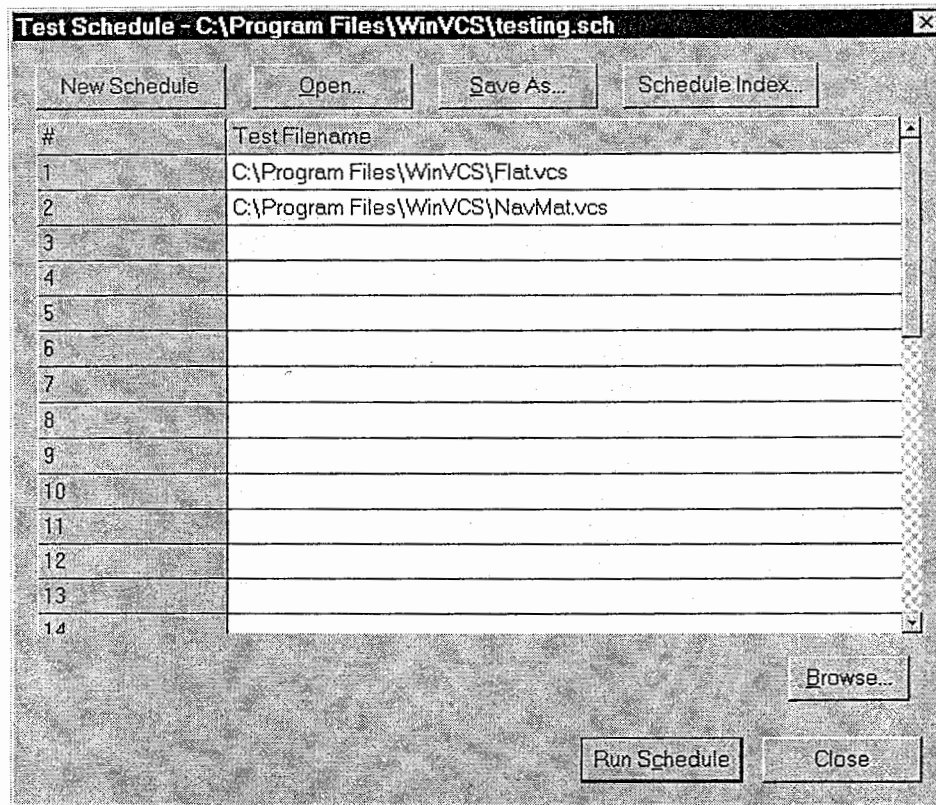
Figure 1-5. Test Schedule Window.
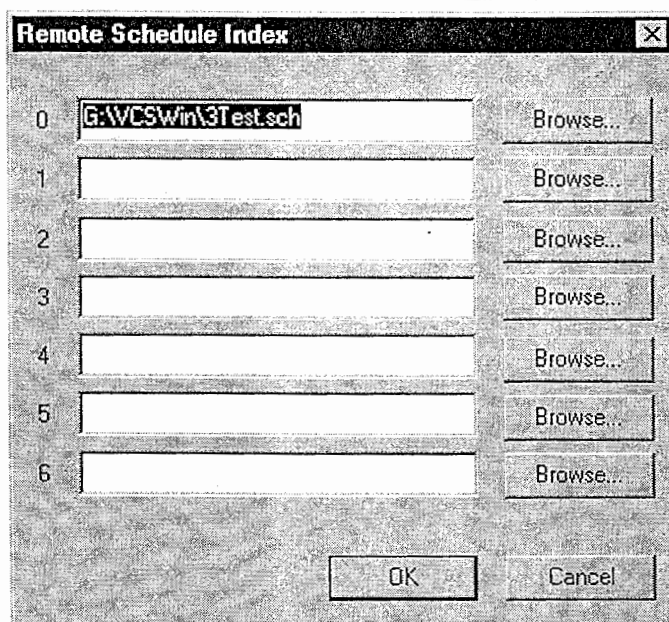
Figure 1-6. Remote Schedule Index Window.

1.4.5. The Technical Displays

The technical displays are windows and dialog boxes that are used to set up the internal system performance, set hardware parameters, or test the system. These windows should be restricted to technicians and engineers who are qualified to perform equipment testing and calibration. The technical displays consist of the General Options and the Calibration Command displays.

1.4.5.1. General Options Displays

The General Options displays allow a technician to set the WinVCS program up for the hardware, and to set the hardware for optimal operations. To access the displays, select the General Options command from the Options menu. Figure 1-7 shows the Program Options window. The Program Options window provides the basic settings for the VCS hardware, networking, and GPIB interface. It also provides general test options that include graphing and test loading preferences.
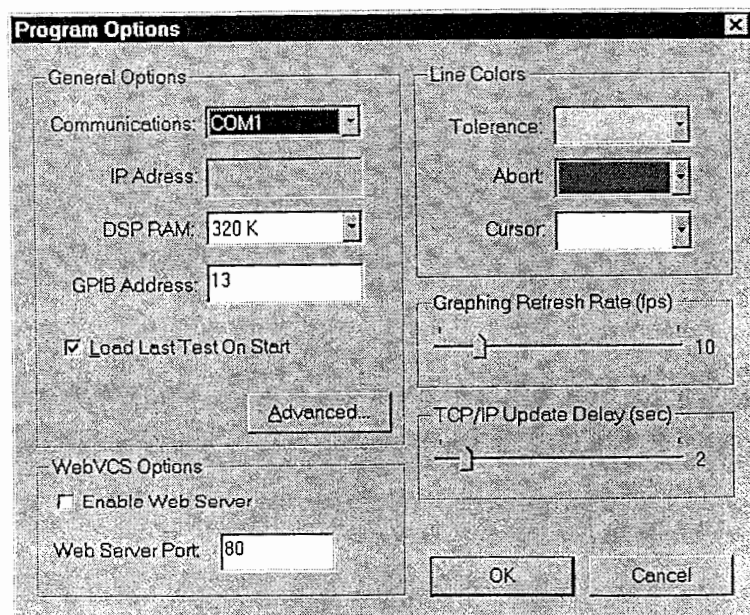
Figure 1-7. Program Options Window.

Press the **Advanced** button on the Program Options window to access the Advanced Options window. See Figure 1-8. This window displays internal control parameters for each vibration mode. They adjust the internal control algorithms and other functions of the WinVCS vibration modes. See Section 6 to use the Advanced Options window.
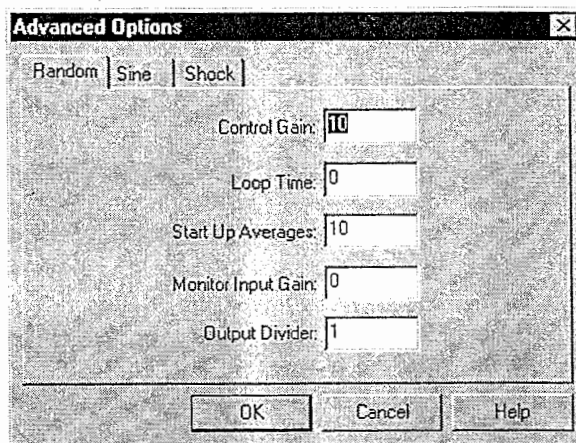
Figure 1-8. Advanced Options Window.

1.4.5.2.   The Calibration Command Windows

The Calibration Command windows allow you to enter the certified sensitivity of each accelerometer and check the accuracy of the VCS and the closed loop with the shaker. You access each window from the Calibration menu. The Calibration Command windows are described below. See Section 7 to operate the Calibration Command windows.

Edit Calibration Factors Window

The Edit Calibration Factors window allows you to enter the certified sensitivity of the accelerometer connected to each input channel. See Figure 1-9.
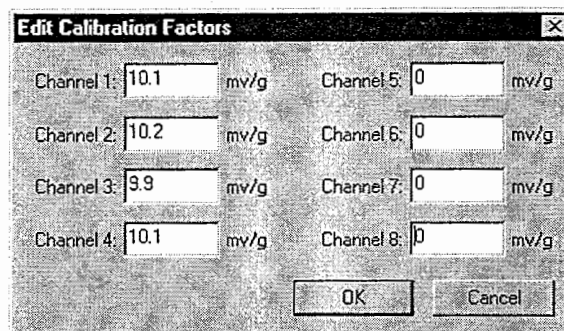
Figure 1-9. Edit Calibration Factors Window.

Live Calibration Window

The Live Calibration Window allows you to check the response of the closed loop system, consisting of the VCS, shaker, and one accelerometer channel at a time. See Figure 1-10. This window is for maintenance purposes only. Its test circuits are not as accurate as the calibration instruments used to certify the sensitivity of the accelerometer.
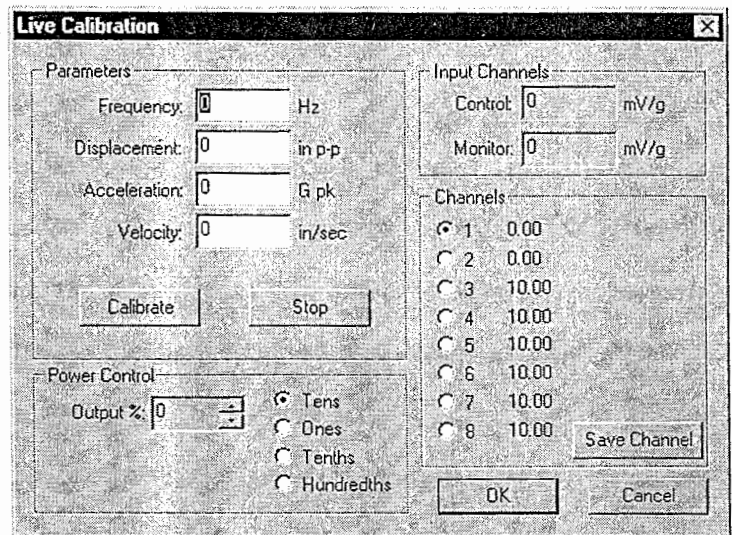
Figure 1-10. Live Calibration Window.

Input Verification Window

The Input Verification window allows you to test the accuracy of the I/O module's input channels. See Figure 1-11. Use this window with a sine oscillator to check each input channel.
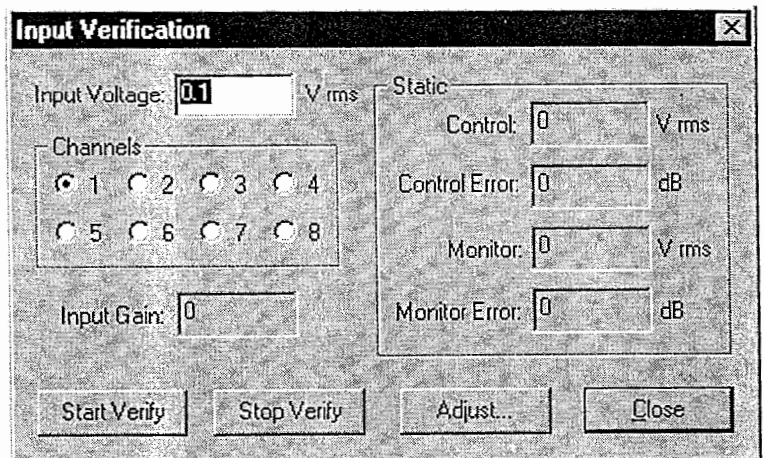
Figure 1-11. Input Verification Window.

Section 2
Operating WinVCS

2. Overview

This section guides you through the windows and displays that operate the WinVCS system. First, it describes the WinVCS window with its menu commands, toolbar buttons, and displays. Next, it provides the test assigning, operating, and viewing procedures. Finally, it provides the procedures for storing and retrieving test data.

2.1. WinVCS Window Commands and Controls

The WinVCS window is the primary window for the program. See Figure 2-1. Its control and displays allow you to operate the system in the Random, Sine, or Shock vibration mode without exiting to another portion of the software system. The following paragraphs describe the different screen functions and displays.

2.1.1. The Menu Bar Commands and their Toolbar Buttons

The menu bar provides nine pull-down menus that provide access to the WinVCS commands and functions. In addition, many of the commands have toolbar or control panel buttons that perform the same operations as the commands. Table 2-1 on at the end of this section describes the commands and their related buttons. Note that table 2-1 does not describe the standard Windows '95 commands.

2.1.2. The Control and Status Panels

The WinVCS panels display the operational controls and status of the system as it runs a test. The control panel displays the operational buttons and lamps that allow you to operate the system with the click of a mouse button. Table 2-1 describes the control panel buttons under the Graph and Command menus. The control panel displays three lamps:

- The Run State lamp turns green when WinVCS is operating the shaker. When you run a test, the lamp flashes until the drive and control response signals stabilize. When you hold a test, the lamp flashes yellow until the test is resumed or stopped.

- The Warning lamp turns yellow whenever the response plot is crossing the inner limit lines, called the tolerance limits.

- The Abort lamp turns red when the response plot crosses the outer limits, called the abort limits. If the Abort lamp comes on, the test shuts down.
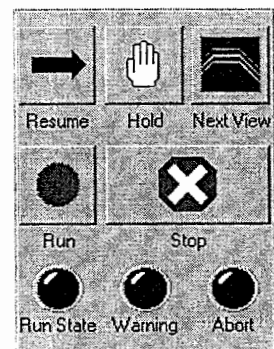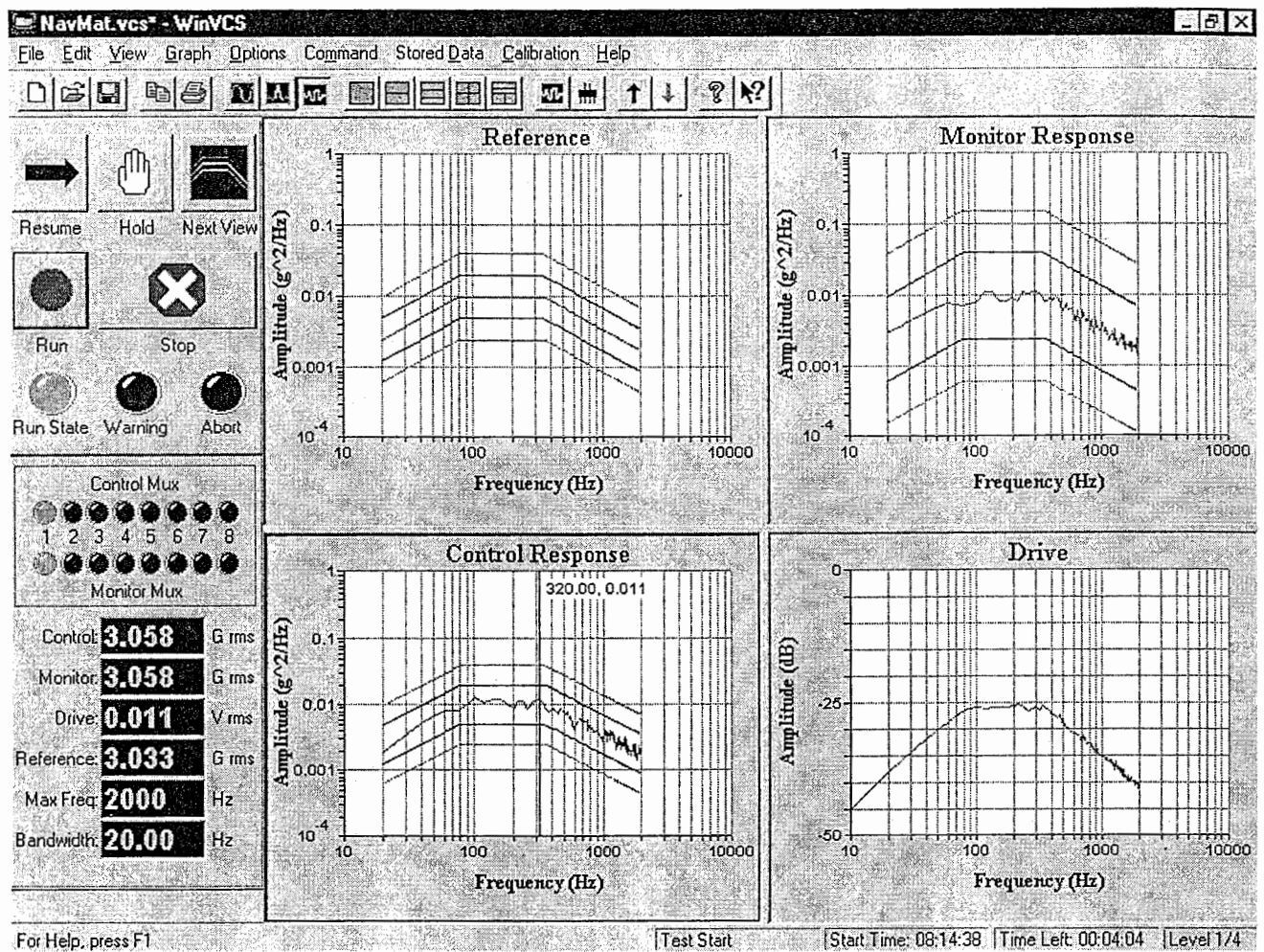
Figure 2-1. WinVCS Window with the Cursor Enabled in the Control Response Graph.

The status panel displays the accelerometers being used during a test, and the real-time readings and settings of the test:

1.   The multiplexer graphic turns the active accelerometer lamps green.

   •   The top row displays the control accelerometer(s).

   •   The bottom row displays the monitor accelerometer(s).

   •   All active accelerometers that are defined in the current test are green.

   •   Any inactive accelerometers that are defined in the current test are red.

   •   Any undefined accelerometer channels are black (off).

2. The Random Mode status panel displays the following parameters during a random vibration test. See Section 3 for a detailed description of the Random mode parameters.

    - Control and monitor channel acceleration readings.

    - Drive signal output.

    - The Reference Profile's acceleration set point.

    - The maximum frequency range of the test.

    - The filter band applied to the test. The filter band equals the maximum frequency of the test divided by the number of lines selected for the test. In the example, the number of lines would be 100 (2000/100=20.00).

Control rms:	59.743	g
Monitor rms:	59.743	g
Drive rms:	0.022	V
Target rms:	59.393	g
Max Freq:	2000	Hz
Bandwidth:	20.00	Hz

3. The Sine status panel displays the signal readings, velocity, and acceleration, depending on which segment of a Sine test is being performed. The panel displays the following parameters:

    - Control and monitor accelerometer readings in the current segment's scale.

    - Current frequency of the signal.

    - Peak output of the drive signal.

    - Reference Profile set point in the current segment's scale.

    - The control type (displacement, velocity, or acceleration) used during the current segment.

Control pk:	5.000	g
Monitor pk:	5.000	g
Freq:	168.153	Hz
Peak Out:	0.300	V
Ref peak:	5.000	g
Type:	Accel	

See Section 4 for a detailed description of the Sine mode parameters.

4. The Shock status panel displays the following parameters:

    - Current acceleration peak.

    - Peak acceleration set point.

    - Voltage peak of the current drive signal.

    - Pulse width in milliseconds.

    - Shape of the pre-pulse and post-pulse in percent. The higher the percentage the sharper the pre-pulse and post-pulse.

    - Phase delay, which automatically compensates for the time delay between the drive output and the response by adjusting the refresh rate a calculated number of frames per pulse.

Peak:	7.467	g
Peak Ref:	7.079	g
Max Drive:	0.249	V
Width:	11.000	ms
Pre/Post:	40.000	%
Ph. Delay:	0	Frame

See Section 5 for a detailed description of the Shock mode parameters.

2.1.3. The Graphic Displays

The graphic displays are interactive charts of the different signal measurements. Each vibration mode has its own set of screens that are listed in this topic and described in more detail in sections 3, 4, and 5. Figure 1-1 shows some of the Random Vibration mode graphs displayed in a four-Graph configuration.

- To display the graphs in different configurations, use the Graph Layout buttons shown to the right.

- When you click on an active graph, a vertical line appears on the graphic, and WinVCS displays the coordinates where the drive or response plot crosses the graph. Double-click the graphic to remove the line.

- To select a graph for the Copy functions, click on it with the mouse. (You can also select the graph from the Graph menu.) A subtle black border appears around the selected graph. You can then copy the graph to the clipboard.

- To print a graph, select the appropriate page layout from the Page Layout command on the File menu, and then select the Print option from the File menu. **NOTE:**   Set the "currently selected" graph by clicking on a graph.

- If you right-click a graph a pull-down list appears that allows you to select the graph and to access the graphing features for the selected graph.

- When you select The Next View button, the selected display shows the next sequential graph in the Graph command list.
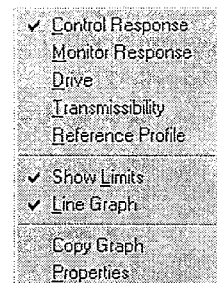
As stated earlier, each of the vibration modes display their own set of graphs. These graphs are listed below:

1. The Random mode frequency-domain (Hz) graphs provide the following information:

    - The Reference graph shows the power spectral density set point.

    - The Control and Monitor Response graphs show the power spectral density of the readings from each accelerometer.

    - The Drive graph shows the drive signal output.

    - The Transmissibility graph shows ratio of the PSD levels of the monitor channels to the control channels.

2. The Sine mode frequency-domain (Hz) graphs provide the following information:

    - The acceleration of the accelerometers.

    - The velocity of the accelerometers..

    - The displacement of the accelerometers.

    - The Drive graph shows the drive signal output.

    - The Transmissibility graph shows ratio of the PSD levels of the monitor channels to the control channels.

3. The Shock time-domain (ms) graphs provide the following information:

- Acceleration of the accelerometers.

- Velocity of the accelerometers.

- Displacement of the accelerometers.

- The Drive graph shows the drive signal output.

2.2. Starting WinVCS

Once you install the program, you can run it from its icon on the desktop or from the Start Menu. Either selection starts the WinVCS program. The WinVCS program opens the WinVCS Window to provide access to the program.

CAUTION: When you start WinVCS, set the shaker amplifier to a gain of zero (0). The I/O module can develop voltage spikes during start-up that can damage the amplifier. Once WinVCS displays its main window, set the amplifier's gain to the desired level.

- To run the program from the desktop, select the WinVCS icon.

- To run the program from the Start menu, select Start, Program Files, WinVCS, and WinVCS.

2.3. Running a Test

Follow these steps to run a test:

1. To open an existing test:

   a. Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

   b. Select the desired VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2. To create a new test:

   a. Select the Sine, Shock, or Random mode from the tool bar or the Option menu.

   b. Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 3, 4, or 5 to define a test in the Random, Sine, or Shock mode.

3. To run the currently defined test, select Run from the control panel or Command menu. The test starts, and WinVCS operates the shaker to start the test.

   a. The Run mode starts the test at Level 1. It first checks the response for a minimum start voltage (Random is in Vrms, Sine is in Vpk, and Shock is in mV). Once it detects the response, the system starts up according to the Start mode on the Level schedule:

       i)   Random or Shock tests can define a Model Start or Resume Start mode. In theses modes, the level looks for a stored drive. If a drive was saved the last time this test was run, WinVCS immediately goes to the saved drive.

      ii)   If the level does not use a saved drive, the VCS equalizes to the level 1 output.

  b.   Once the signal equalizes within the Tolerance limits, the clock counts down for the current level.

  c.   Once the clock times out, the VCS moves to the next level:

      i)   If the next level has a defined Model or Resume mode, the level looks for a stored drive. If a drive was saved the last time this test was run, WinVCS immediately goes to the saved drive.

      ii)   If the next level does not use a saved drive, the VCS equalizes to the level's defined output.

  d.   The test repeats steps b and c until it executes all the levels. Then it stops.

4.   During a test, you can select Next Level (⬆) or Previous Level(⬇) from the Command menu or toolbar to move the test up and down the level schedule immediately:

  a.   If the level has a defined Model or Resume mode, the level looks for a stored drive. If a drive was saved the last time this test was run, WinVCS immediately goes to the saved drive.

  b.   If the level does not use a saved drive, the VCS equalizes to the level's defined output.

5.   During a Random or Shock test, you can define a Model Start or Resume Start mode for each level. These modes allow you to save drive outputs to save the equalization time. See Using a Model Drive later in this section for the Model Start and Resume Start mode procedures.

6.   Select Step Mux (⊞) from the Command menu or toolbar to step the monitor response graph to the next defined monitor channel.

7.   Follow these steps to operate in the Hold mode:

  a.   Select Hold from the Command menu or control panel to place the test in the Hold mode. The Run State lamp flashes yellow.

  b.   WinVCS outputs a fixed drive at the current level. It stops the clock and suspends limit checking.

  c.   Select Run or Resume to continue the test from hold. Either command continues the test from the current drive and clock setting. It also enables limit checking.

8.   To stop a test, select Stop from the Command menu or control panel.
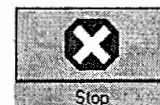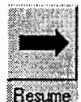
9. During a test, you can use the following commands to send a copy of selected test data to a printer or a file:

    a. Select Print Test Options from the File menu to send a report of the defined test options to the printer or file.

    b. Select Print (🖨) from the File menu or toolbar to send the graph to the printer or file. The Print Layout option on the File menu sets the graph layout. To set the "currently selected" graph, click on the graph in the WinVCS window, or select it from the graph menu.
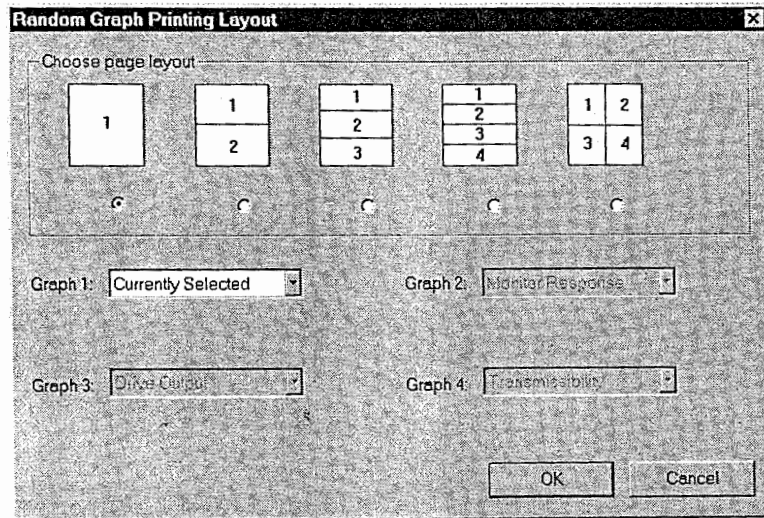
Figure 2-2. Graph Printing Layout Window

    c. Select Copy (📋) from the Edit menu or toolbar to send a copy of the selected graph to the Windows '95 clipboard. To select a graph, click on the graph in the WinVCS window.

10. See Using the Stored Data Commands later in this section to store test data.

2.4. Assigning and Running a Test Schedule

The Test Schedule command allows you to run several vibration tests consecutively. These tests can be in different vibration modes. In addition, you can assign up to seven test schedules to be run from the I/O module. The I/O module has three Test Schedule bit terminals that allow you to select the tests using a binary format. See Section 7 for a description of the Test Schedule bits.

Follow these steps to assign and run a test schedule:

1. Select Schedule Tests from the Options menu to display the Test Schedule window. See Figure 2-3.

2. Select New Schedule to open a blank table.

3. To open a stored test schedule:

    a. Select Open... to display the Open dialog box. The dialog box displays all the test schedule files with the ".sch" extension in the default folder.

    b. Select the desired test schedule (.sch) file from its folder path. WinVCS displays the file's assignments in the table area.

4. To remove a line from the table:

    a. Double-click the appropriate row's Test Filename field.

    b. Highlight the text and press the **DELETE** key. All the lines below move up once the schedule is re-opened.
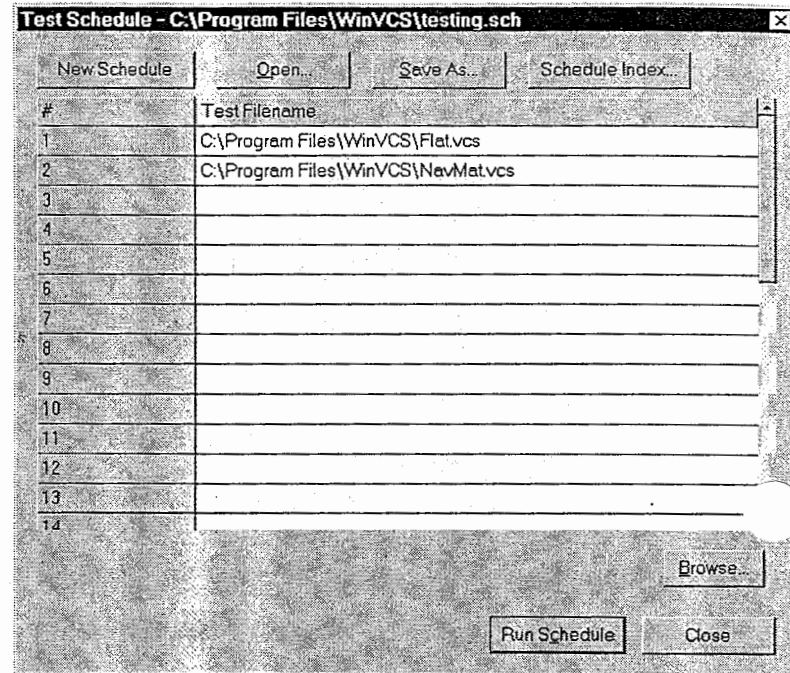
Figure 2-3. Test Schedule Window

5. To edit a line:

    -   Double-click appropriate row's Test Filename field, highlight any existing text, and type the file name and path.

    -   Select the test from a folder.

        i)   Select Browse... to display the Open dialog box.

        ii) Navigate to the desired file.

        iii) Double-click the file. WinVCS displays the file name and path in the Test Filename field.

6. Select Save As... to save the schedule.

    a. The Save As dialog box opens.

    b. Save the test to a file using the ".sch" file extension.

7. Select [Run Schedule] to run the displayed Test Schedule.

   a. WinVCS runs the tests in the order listed on the schedule.

   b. See "Running a Test" to perform different operations on each test as it runs.

8. To assign different test schedules for external selection:

   a. Select [Schedule Index...] to display the Remote Schedule Index Window. See Figure 2-4.

   b. Select the **Browse** button by the index line you wish to edit. WinVCS displays the Open dialog box with the Test Schedule (.sch) type files displayed.

   c. Select the file that you wish to assign to the index number. WinVCS displays the full file path in the index field.

   d. Repeat steps b and c for each index assignment.

   e. Once you finish, select [-OK]. The window closes. You can now run each of the schedules assigned to an index from the I/O module's external input terminals.
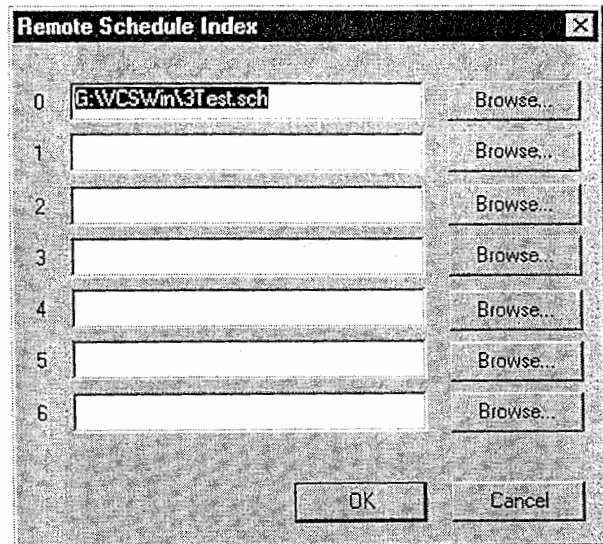
Figure 2-4. Remote Schedule Index Window.

2.5. Viewing and Adjusting the Graphs

As you run a test or view historical data, you can adjust the graphic display to view a variety of different graphs. In addition, you can change the properties that set the graphic scales and other display features. The following procedures describe how to perform the above tasks. You can perform these tasks with a defined test in any operating mode (Run, Stop, or Hold.)

Follow these steps to view and adjust the graphs:

1. To open an existing test:

    a. Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

    b. Select the desired VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2. To create a new test:

    a. Select the Sine, Shock, or Random mode from the tool bar or the Option menu.

    b. Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 3, 4, or 5 to define a test in the Random, Sine, or Shock mode.

3. To select the graphic layout, use the following View menu Commands or toolbar buttons:

    a. 1 Graph displays a single large graph in the graph area.

    b. 2 Graphs displays two horizontally tiled graphs.

    c. 3 Graphs displays three horizontally tiled graphs.

    d. 4 Graphs displays four graphs as four quadrants of the graph area.

    e. Combined Layout displays two graphs that are horizontally tiled on top, and two graphs that are vertically tiled on bottom.

4. To change the display on a graph:

    a. Right-click on the graph to open its View commands display. See Figure 2-5.

    b. Select the graph you wish to display from the list of graphs.

5. To change the line displays on a graph:

    a. Right-click the graph.

    b. Click on Show Limits to turn the tolerance and abort limits on or off.
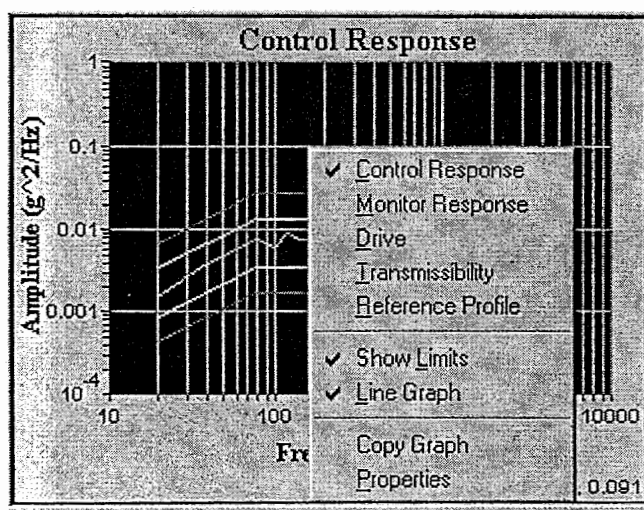
Figure 2-5. View Commands for a Single Graph.

    c.   Click on Line graph to turn the line connection on the plot on or off.

        i)   With the lines turned off, the plot is displayed as separate points according to the filter resolution.

        ii) With the lines turned on, the plot "connects the dots" to provide a line graph.

6.   To copy a graph to the Windows '95 clipboard:

    a.   Right-click the graph.

    b.   Select Copy Graph.

7.   To edit a graph's scale and colors:

    a.   Right-click the graph.

    b.   Select Properties to display the graph's properties. See Figure 2-6.

    c.   To change a Scale selection:

        i)   Select the Scale list box.

        ii) Select Log for Logarithmic scale, or Linear for a linear scale.

    d.   Enter the minimum and maximum limits for each axis into their fields.

        i)   Log displays its limits in powers of 10. For example, any selection from 1001 to 10000 would select a scale of 10000.

Figure 2-6. Example Graphing Properties Window for a Graph.

        ii) Linear displays the exact limits that you select.

    e.   Select each graph color from its pull-down list.

    f.   Select [OK] to accept all the edits and exit to the graph.

NOTE: Use the Option menu's General Options command to display and edit the Tolerance, Abort, and Cursor line colors. If needed, see Section 6 for the procedure.

8.   Follow these steps to set up the auto-save and energy graph options:

    a.   Select Properties from the Graph menu. The Properties window opens. See Figure 2-7.

    b.   Enter a title for the defined test's graphs into the Display Title fields. This title appears at the top of each print out or graphic print out.

Figure 2-7. Sample Graphing Properties Options Display.

   c.   On Random mode Options displays, select the Response Display energy from the pull-down list:

      i)   Defined Energy filters out all noise and other energy that does not apply to the test.

      ii)   All Energy displays all noise, harmonics and other factors that may be present.

   d.   Select the following auto-save and hard-copy options:

      i)   The Auto Save checkbox or checkboxes select the responses that you wish to save each time WinVCS stops.

      ii)   The Auto Hard Copy checkbox sends a copy of the data to the printer output each time the auto-save occurs.

      iii)   Select the Save at new level checkbox to enable the Auto Save and Auto Hard Copy at each level of the test.

      iv)   The Auto Save Parameters save the data under the following formats:

         •   Random mode saves the response plot of the control and/or monitor spectrum. WinVCS saves the data under the test name, followed by a three-number file extension that increments each time you save the data. (i.e., Navmat.000, Navmat.001, Navmat.002, etc.)

         •   Sine mode saves the displayed graph data for the currently running test in a storage file. WinVCS saves the data under the test name, followed by a three-number file extension that increments each time you save the data. (i.e., Sweep.000, Sweep.001, Sweep.002, etc.)

2.6. Accessing the Test Options

Once you open a defined test, you can locate the test definitions in the Test Options window. Each vibration mode has its own test options. See the detailed descriptions and procedures for the test options in sections 3, 4, and 5. This procedure describes how to access them during a test.

Follow this procedure to access the test options:

1.   To open an existing test:

   a.   Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

   b.   Select the desired VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2.   To create a new test:

   a.   Select the Sine, Shock, or Random mode from the tool bar or the Option menu.

   b.   Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 3, 4, or 5 to define a test in the Random, Sine, or Shock mode.

3.   Once a defined test is opened, you can access the test options from the Run, Stop, or Hold modes.

   a.   Any changes to the test will affect the test as soon as you finish editing the parameters.

   b.   If you edit a parameter, an asterisk (*) appears next to the file name at the top of the WinVCS window to indicate that the file was changed.

4. Select the Test Options command from the Options menu. WinVCS opens the System Properties window for the defined test. Figure 2-8 shows the Sine Control System Properties window.

5. Select the tabs to display the different test definition displays. These displays provide all the parameters that define a test. Sections 3, 4, and 5 provide descriptions and procedures for each vibration mode's display.

6. To edit a non-table parameter:

   a. Select the tab that displays the parameter.

   b. To edit a field, type in the desired value or name.

   c. To edit a list box:

      i) Click on the pull-down list arrow.

      ii) Select the desired parameter.

7. To edit a table parameter:

   a. Select the tab that displays the table. See Figure 2-9.

   b. To remove a line from the table:

      i) Select an entire row by single clicking any field in the row.

      ii) Press the **DELETE** key. All the lines below move up once the table is reopened.

   c. To edit a line:

      i) Click the appropriate field, or use the arrow keys to navigate the table.

      ii) Enter the data into the field (or select it from a pull-down list).

      iii) Repeat steps i and ii as needed.

Figure 2-8. Sine Control System Properties Window.

Level	Test Time	dB Level	g rms Level	% Level	Start
1	00:00:00	0.00	0.00	100.00	Normal
2	00:00:00	0.00	0.00	100.00	Normal
3	00:00:00	0.00	0.00	100.00	Normal
4	00:00:00	0.00	0.00	100.00	Normal
5	00:00:00	0.00	0.00	100.00	Normal
6	00:00:00	0.00	0.00	100.00	Normal
7	00:00:00	0.00	0.00	100.00	Normal
8	00:00:00	0.00	0.00	100.00	Normal
9	00:00:00	0.00	0.00	100.00	Normal
10	00:00:00	0.00	0.00	100.00	Normal
11	00:00:00	0.00	0.00	100.00	Normal
12	00:00:00	0.00	0.00	100.00	Normal
13	00:00:00	0.00	0.00	100.00	Normal

Figure 2-9. WinVCS Table

8. Once you finish editing or viewing the System Properties window for the test, close the window as follows:

   a. Select **OK** to apply any edits to the test. WinVCS applies the edits to the test, affecting operations immediately if the test is running.

   b. Select **Cancel** to close the window without afecting the test.

2.7. Using a Model or Resume Drive during Random and Shock Mode Testing

Some Random and Shock mode tests can require a few minutes to equalize the drive output at the desired level. Model drives eliminate the equalization time by immediately applying a known drive output to the shaker. You can define the Level Schedule window's Start mode parameters for a Model or Resume start:

• **Model** allows you to manually save each drive once it equalizes to the different levels of the test. Figure 2-10 shows a Random mode level schedule with Start fields set to Model. The first time you run the defined test, WinVCS equalizes to each level. Once the output equalizes and the test starts, you can save the drive for that level.

• **Resume** allows the WinVCS program to automatically save the drive the first time you run the test. As WinVCS equalizes and then starts the clock, it saves the drive output for that level.

Either mode stores a drive that is used on any tests that follow using the same test file. When WinVCS runs a test with saved drives, it moves quickly between levels by immediately going to the saved drive output.

Random Control System Properties

Test Profile | Abort Parameters | Reference | Control Limits | Monitor Limits | Level Schedule

Level	Test Time	dB Level	g rms Level	% Level	Start
1	00:05:00	0.00	0.00	25.00	Model
2	00:05:00	0.00	0.00	50.00	Model
3	00:05:00	0.00	0.00	75.00	Model
4	00:00:30	0.00	0.00	100.00	Model
5	00:00:00	0.00	0.00	100.00	Normal
6	00:00:00	0.00	0.00	100.00	Normal
7	00:00:00	0.00	0.00	100.00	Normal
8	00:00:00	0.00	0.00	100.00	Normal
9	00:00:00	0.00	0.00	100.00	Normal
10	00:00:00	0.00	0.00	100.00	Normal
11	00:00:00	0.00	0.00	100.00	Normal
12	00:00:00	0.00	0.00	100.00	Normal
13	00:00:00	0.00	0.00	100.00	Normal

OK   Cancel   Help

Figure 2-10. Random Mode Level Schedule with Model Start modes.

CAUTION: Applying a saved drive to a test with modified load or output requirements could damage the shaker! To prevent damage to the system, clear the drives from the modified test before running the test. You can then redefine the model drives for the test according to its new drive or load requirements.

Follow these steps to store or erase Model drives for a test:

1.   To open an existing test:

   a.   Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

   b.   Select the desired VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2.   To create a new test:

   a.   Select the Sine, Shock, or Random mode from the tool bar or the Option menu.

   b.   Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 3 or 5 to define a test in the Random or Shock mode.

3. To erase the stored drives for the defined test, select the Clear Stored Drives command from the Stored Data menu.

    a. WinVCS erases all the stored drives for the defined test.

    b. The test will now equalize at each level.

4. Select the **RUN** button to start the test.

5. Watch the Control Response graph (Random mode) or the Acceleration graph (Shock mode) as the system equalizes between the tolerance limits. Figure 2-11 shows a Random mode Control Response plot that is equalized.

6. Wait until the response or acceleration plot is fully contained inside the tolerance limits.

    a. The Warning lamp remains dark once the full signal is within the tolerance limits.

    b. Once WinVCS determines that the output is equalized, it starts the clock or countdown for the current level.

7. Press the **Ctrl** and **D** keys together to save the drive. (Or select the Save Drive Command from the Stored Data menu.)

8. Perform one of these steps:

Figure 2-11. Random Mode Response Plot Equalized within the Tolerance Band.

    a. Wait until the test moves to the next level in the level schedule.

    b. Select the Next Level () command or toolbar button to move the test to the next level.

9. Repeat steps 6 through 8 for each test level where you wish to save a drive. Remember, the test level must be defined for a Model Start mode.

2.8. Saving and Viewing Historical Test Data

WinVCS allows you to save the test readings as historical data files that you can recall and play back on the graphs.

*   Sine mode allows you to save all the graph data during the selected Auto Save events. In addition, its Save Current Data command allows you to manually save the graph data any time during a test.

*   Random mode allows you to save all the graph data during the selected Auto Save events.

*   Random mode also allows you to record a test and play it back on the graphic displays.

The following procedures describe how to save and then view the historical data.

2.8.1. Saving and Viewing the Data Files

All three vibration-modes allow you to set up the Auto Save functions in the Graphing Properties window. WinVCS saves these files under the defined test's file name and a three-digit extension instead of the original extension (i.e., Sweep.001, Sweep.002, Sweep.003, etc.). In addition, you can manually save the graph data during a test. The following procedure describes how to save and display these files.

Follow these steps to save and display the Sine mode Data files:

1. To open an existing test:

    a. Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

    b. Select the desired Sine mode VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2. To create a new test:

    a. Select Sine, Shock, or Random mode from the tool bar or the Option menu.

    b. Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 4 to define a test in the Sine mode, and see Section 5 for the Shock mode.

3. Follow these steps to enable the Auto Save functions:

    a. Select the Properties command from the Graph menu. WinVCS opens the Graphing Properties window.

    b. Select the desired Auto Save check Boxes:
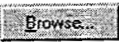
        i)   Auto Save Data enables the automatic saving at Stop. You must check this box to enable Auto Save.

        ii) Save at new level enables the automatic saving at the completion of each level.

        iii) Auto Hard Copy prints out a hard copy of the data to the assigned printing device each time WinVCS performs an auto save.

    c. Select [OK] to apply the selections and close the window.

4. Select the **Run** button to start the test.

5. To manually save all the displayed graph data, select the Save Current Data command from the Stored Data menu.

6. Once the test is in the Stop mode, display the saved data within WinVCS as follows:

    a. Select the View Saved Data command from the Stored Data menu. The Open dialog box opens to the saved test data. The test data files have numeric extensions.

    b. Select the desired data file. WinVCS loads the graph data in its graphic displays.

    c. Repeat steps a and b for each file that you wish to view.

7. To display the saved data as a spreadsheet, import the data file using a spreadsheet program. The file is tab delimited. If the spreadsheet format is not altered, the file can be imported to WinVCS as reference data.

2.8.2. Recording and Playing Random Test Spectrum Files

The Random mode recording functions allows the entire Random test to be recorded into a file. To accomplish this, the Random mode uses Stored Data commands with toolbar buttons that resemble the controls on a recording device like a cassette deck.

Follow these steps to record and play random tests:

1. To open an existing test:

    a. Select Open Existing Test (Ctrl+O) from the File menu. WinVCS displays the Open dialog box with the available VCS tests in the default folder.

    b. Select the desired Random mode VCS test from the default folder or another location. All VCS tests have the ".vcs" file extension. WinVCS loads the defined test into the WinVCS window and automatically selects the vibration mode.

2. To create a new test:

    a. Select Random mode ( ) from the tool bar or the Option menu.

    b. Select New Test (Ctrl+N) from the File menu. WinVCS opens the test definition wizard for the selected vibration mode. See section 3 to define a test in the Random mode.

3. Select the **Run** button to start the test.

4. To record a portion of the test:

    a. Select Record ( ) from the Stored Data menu or the toolbar. WinVCS stores the response spectrum readings into the recording file (file extension .rec) location defined in the Stored Data Filename field of the Random Control System Properties window.

    b. Select Stop ( ) from the Stored Data menu or the toolbar to stop the recording.

5. To play back the last recording for the test, select Play ( ) from the Stored Data menu or the toolbar. WinVCS plays back the entire test during the time that the Record command was enabled.

6. To play back a stored data recording file:

    a. Select the Test Options command from the Options menu. The Random Control System Properties window opens.

    b. If needed, select the Test Profile tab to display the Stored Data Filename field:

    Stored Data Filename
    G:\WinVCS\Navmat.rec   Browse...

    c. Select Browse... to display the Open dialog box.

    d. Locate the desired recording file, and select it. WinVCS displays the file path in the Stored Data Filename field.

    e. Select Play ( ) from the Stored Data menu or the toolbar. WinVCS plays back the entire test during the time that the Record command was enabled.

2.9. Table of WinVCS Window Commands and Buttons

Table 2-1 lists the menu bar commands, toolbar buttons, and control panel buttons.
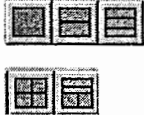
Table 2-1. WinVCS Window Commands and Buttons. Page 1 of 4.		
Command	Toolbar or Control Panel Button	Description
File Menu Commands		
New Test		Opens the test definition wizard for the currently selected vibration mode. Use this command to define a new vibration test. Once you finish defining the test, WinVCS loads it as the current test.
Open Existing Test		Opens a defined test that is stored in a computer file.
Save Test		Saves the test that is loaded into the WinVCS window under its original name.
Print		Sends the currently selected graph layout to the printer. To set the page layout, select the Page Layout option from the file menu. .
Print Preview		Displays of how the currently selected graph layout will appear when printed.
Page Layout		Select the layout for printing the graph(s). Set the "currently selected" graph by clicking on the graph in the WinVCS window
Print Test Options		Sends a report of the currently loaded test's defined options to the printer.
Edit Menu Commands		
Copy		Copy's the currently selected graph to the clipboard. To select a graph, click on the graph in the WinVCS window.
View Menu Commands		
Toolbar		Displays the toolbar and its buttons.
Stored Data Controls		Displays the Random Vibration mode's **Play, Record** and **Stop** buttons used to record and play back the signal performance.
Control panel		Displays the control panel. The control panel displays the operation buttons and lamps, and it displays the **Next View** graph selection button.
Status Panel		Displays the status panel. The status panel displays the accelerometer multiplexer and the real-time parameters.
Status Bar		Displays the status bar. The status bar displays the operational status, the last start time of the active test, and the current level of the test.
Graph Buttons		Allows you to select the different graphic layouts on the WinVCS window. You can display 1 through 4 graphs or 4 graphs in a combined layout.

Table 2-1. WinVCS Window Commands and Buttons. Page 2 of 4		
Command	Toolbar or Control Panel Button	Description
Graph Menu Commands		
Graph Selections		Each vibration mode has its own graph selections. When you click on a graph location and open the Graph menu, it displays a check mark next to the graph currently selected for the graph location. To select a different graph for the location, click on the desired graph name.
Reset Peak Hold Graphics		Sine Vibration mode function that clears the accumulated data from the response plots. It erases the displayed response plots, and it clears the registers that are used to create the plots and average the response frames.
Show Limits		Turns the Tolerance and Abort limit lines on or off on all affected graph displays.
Line Graph		Turns the line connections on or off on the graphs. With the lines turned off, the graph shows the points of resolution where the A/D converters read the responses. With the lines turned on, the graph "connects the dots," showing the graph in line format.
Properties		Displays the Graphing Properties window for the current vibration mode. Use this window to adjust the graphic displays and set up the auto-save or auto-copy modes.
Next View	Next View	Changes the view on the selected graph area to the next graph on the list.
Options Menu Commands		
Test Options		Opens the Test Options window that defines the current test. The Test Options window displays all the fields and tables that define the current test.
General Options		Opens the Program Options window. This window allows you to set up WinVCS according to the hardware installed in the VCS computer, and it provides access to some internal operating parameters for WinVCS. In addition, it provides the global graphing refresh rate and limit-line color controls.
Schedule Tests		Opens the Test Schedule window. This window provides the Test Schedule table for assigning and running multiple tests. It provides access to the Remote Schedule window that allows you to assign up to seven test schedules for remote selection. You can select the remote test schedules through the scheduling-bit terminals on the I/O module.
Mode		Provides the Vibration Mode selections. The buttons, shown to the left, select the Sine, Shock, or Random mode in that order. The Vibration Mode selection sets up the WinVCS window displays and commands for the selected mode.
Control Servo Fixed		Used in Sine mode to create a response plot of the shaker armature. Mark (enable) this command to output a drive at a fixed voltage. Clear (disable) this command for all other operations.
System Status		Displays the monitor and control inputs' current mv/g or mv/m/s^2 sensitivity calibration factors, the control gain, and the monitor gain settings.

Table 2-1. WinVCS Window Commands and Buttons. Page 3 of 4.		
Command	Toolbar or Control Panel Button	Description
Command Menu Commands		
Run		Places a test in the Run mode from the Stop mode or the Hold mode: • From the Stop mode, the Run mode starts the test at Level 1. It first checks the response for a minimum start voltage (Random is in Vrms, Sine is in Vpk, and Shock is in mV). Once it detects the response, the system starts up according to the Start mode on the Level schedule. • From the Hold mode, the run mode resumes the test at the current drive, and allows the test clock to continue counting down.
Stop		Places a test in the Stop mode, ending the test.
Resume		Continues test from the Hold mode at the current drive, and allows the test clock to continue counting.
Hold		Suspends the test, causing the WinVCS to output a fixed drive signal and stop the test clock. Hold mode also suspends tolerance and abort limit checking. The Run Status lamp flashes yellow while the test is in hold mode.
External Inputs		Records an external signal input from the selected accelerometer channels in the Random mode. Used during the Random Mode's procedure for creating an external profile.
Step Mux		Steps to the next defined monitor channel. The status panel displays all the active monitor channels as green lamps. If a test defines an inactive channel, the status panel displays the inactive channel in red.
Next Level		Advances the test to the next level defined on the level schedule. WinVCS starts the next level based on the level's defined Start mode. WinVCS disables this command when the test reaches the last level.
Previous Level		Backtracks the test to the previous level in the defined level schedule. WinVCS starts the previous level based on the level's defined Start mode. WinVCS disables this command when the test is on the first level.

Table 2-1. WinVCS Window Commands and Buttons. Page 4 of 4.		
Command	Toolbar or Control Panel Button	Description
Stored Data Menu Commands		
Play	▶	Plays the record defined by the Random mode Test Option window's *Stored Data Filename* field. WinVCS displays the file output on its graphs. You can use the Record command to play back the current recording without changing the field. To play another stored record, first use the Test Options command to select the desired recording (file extension .rec) from its file folder.
Record	●	Records a copy of the currently running test in the (.rec) filename defined in the Test Option window's *Stored Data Filename* field.
Stop	■	Disables the Play or Record command. This ends the recording to a record (.rec) file or the playing back from a record file.
Save Drive		Random or Shock mode function that saves the drive during a test for the Model Start mode of the defined level schedule.
Clear Stored Drives		Random or Shock mode function used to clear the drives stored for the Model Start or Resume Start modes of the level schedule.
Save Current Data		Saves the data for the currently running test in a storage file. WinVCS saves the data under the test name, followed by a three-number file extension that increments each time you save the data. (i.e., Sweep.000, Sweep.001, Sweep.002, etc.)
View Saved Data		Allows you to load the data saved using the Save Current Data command. WinVCS loads the data into the WinVCS window graphs for display.
Calibration Menu Commands		
Edit Factors		Opens the Edit Factors window. This window allows you to enter the certified sensitivity of the accelerometer attached to each input channel.
Live Calibration		Opens the Live Calibration window. The Live Calibration Window allows you to check the response of the closed loop system, consisting of the VCS, shaker, and one accelerometer channel at a time.
Input Verification		Opens the Input Verification window. The Input Verification window allows you to test the accuracy of the I/O module's input channels.

Section 3
Random Vibration Mode

3. Overview

The Random Vibration mode functions allow you to define, edit, run, and view random vibration tests. This section describes the Random Vibration mode graphs, and it provides the procedures for defining and editing Random mode tests. In addition, its Special Programming and Operating Techniques topic provides operating instructions for special Random mode functions.

3.1. The Random Mode Graphs

The Random mode graphs display the defined test and the real-time closed loop displays during the test. The defined test plots the desired response plot from the shaker. The real-time closed loop graphs show how the system is operating to achieve the desired response:

• The Reference graph plots the demand plot created by the test definitions.

• The Response graphs plot the actual accelerometer readings from the shaker.

• The Drive graph plots the drive signal output to the shaker amplifier.

• The Transmissibility graph plots the response ratio between the monitor and control accelerometer readings.

The following topics describe each type of graph.

3.1.1. Reference Profile Graph

The Reference Profile graph displays the demand PSD plot in g^2/Hz over a defined frequency band. See Figure 3-1. The demand plot is the center plot of the graph. You define or edit the demand plot from the Reference Table window described later in this manual. The demand plot defines the response the closed-loop system is working to achieve during the test. The demand plot is surrounded by two bands:

- The tolerance band is displayed as the two plot lines that are closest to the demand plot. They display the acceptable amplitude limits for the test.

- The abort band is displayed as the two outer plot lines. They display the absolute amplitude limits of the test. The test aborts if the response exceeds these limits.
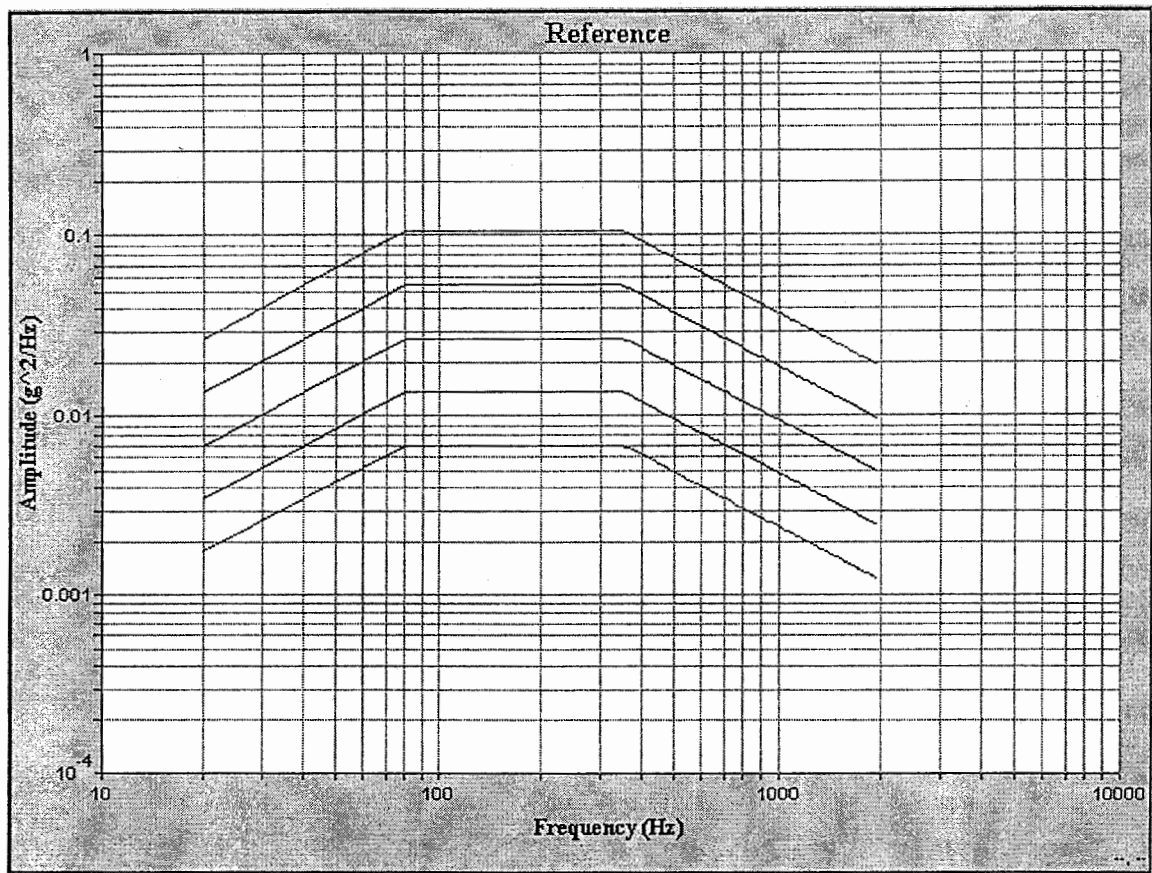
Figure 3-1. Sample Random Mode Reference Graph

3.1.2. Response Graphs

The Control and Monitor Response graphs display actual response from the control and monitor accelerometers that are mounted on the shaker. Figure 3-2 shows a sample Control Response plot. Like the Reference graph, the response graphs can also display the abort and tolerance limits. The reference plot is replaced by the real-time response of the accelerometers in g^2/Hz over the range of a frequency-domain graph.

- The Control Response graph displays the response used by WinVCS to adjust its demand output to the shaker. The control response is a part of the closed-loop control system.

- The Monitor Response graph displays the response of other areas around the product or shaker. This response is calculated separately and is not a part of the closed-loop system.
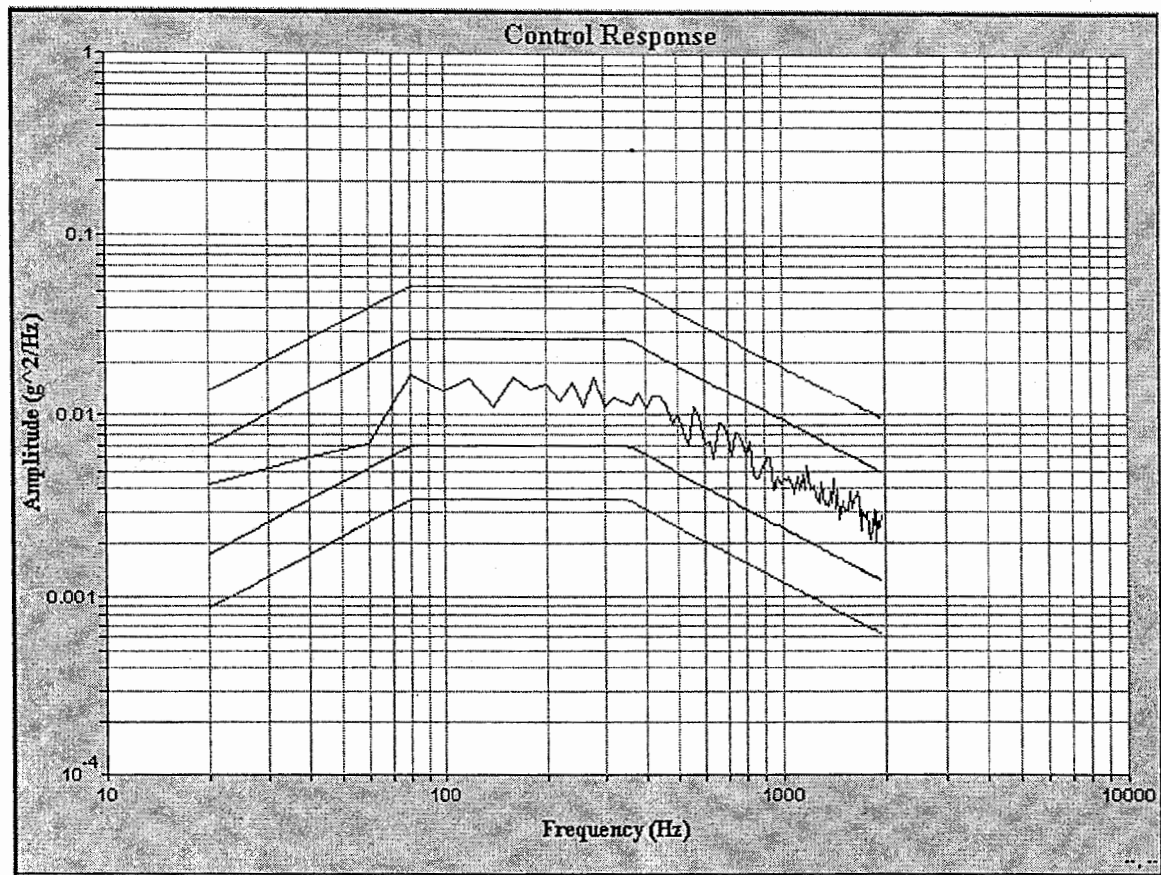
Figure 3-2. Sample Random Mode Control Response Plot

3.1.3. Drive Graph

WinVCS plots its actual frequency-domain drive signal output on the Drive graph. See Figure 3-3. The graph shows the amplitude of the drive signal's voltage in decibels over the defined frequency range. WinVCS converts this signal to a time-domain drive signal that is applied to the shaker amplifier through the VCS I/O module.
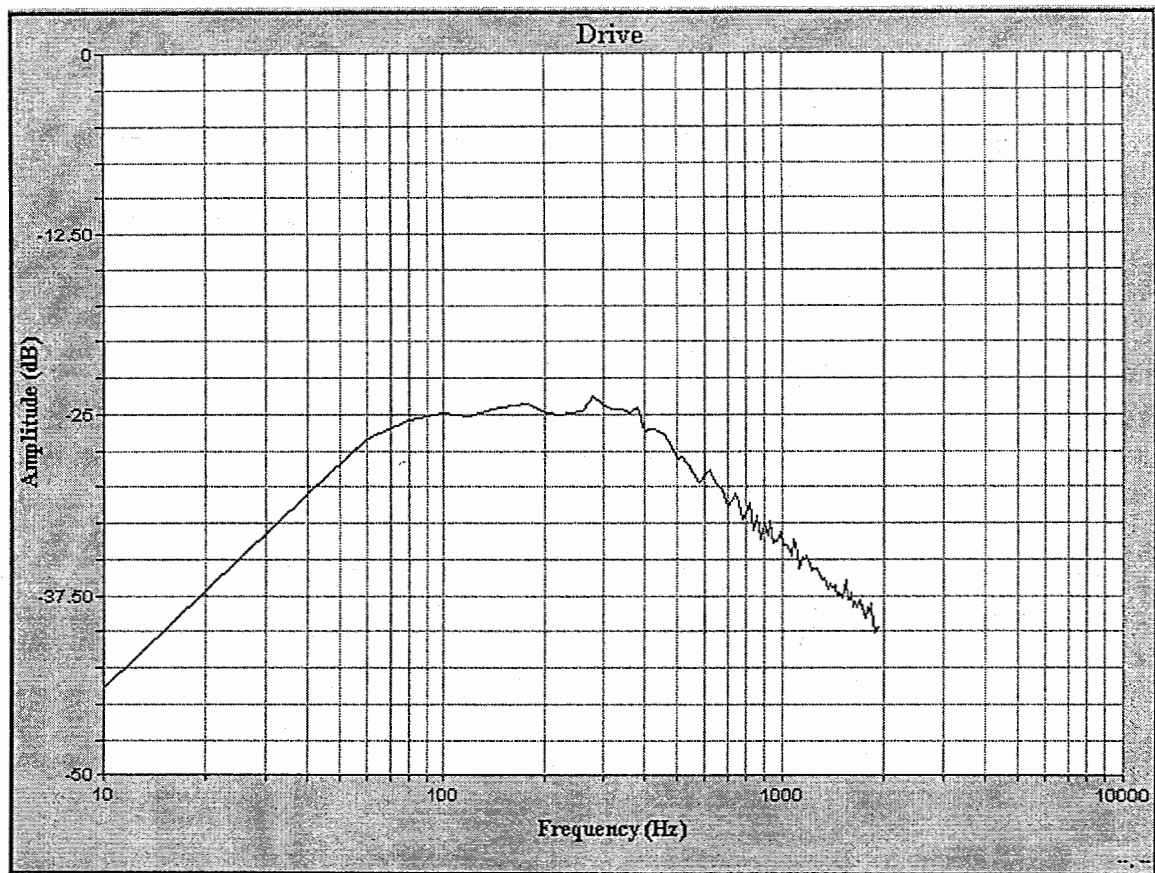
Figure 3-3. Sample Random Mode Drive Graph.

3.1.4. Transmissibility Graph

The Transmissibility graph displays the response ratio between the monitor and control accelerometers. WinVCS plots the monitor response (g's) divided by the control response plot (g's) across the defined frequency band.

You can use this graph to find resonance points on your product. Place the monitor accelerometer on your product and the control accelerometer on your product fixture. As you run a test, observe the ratio between the product and the fixture.
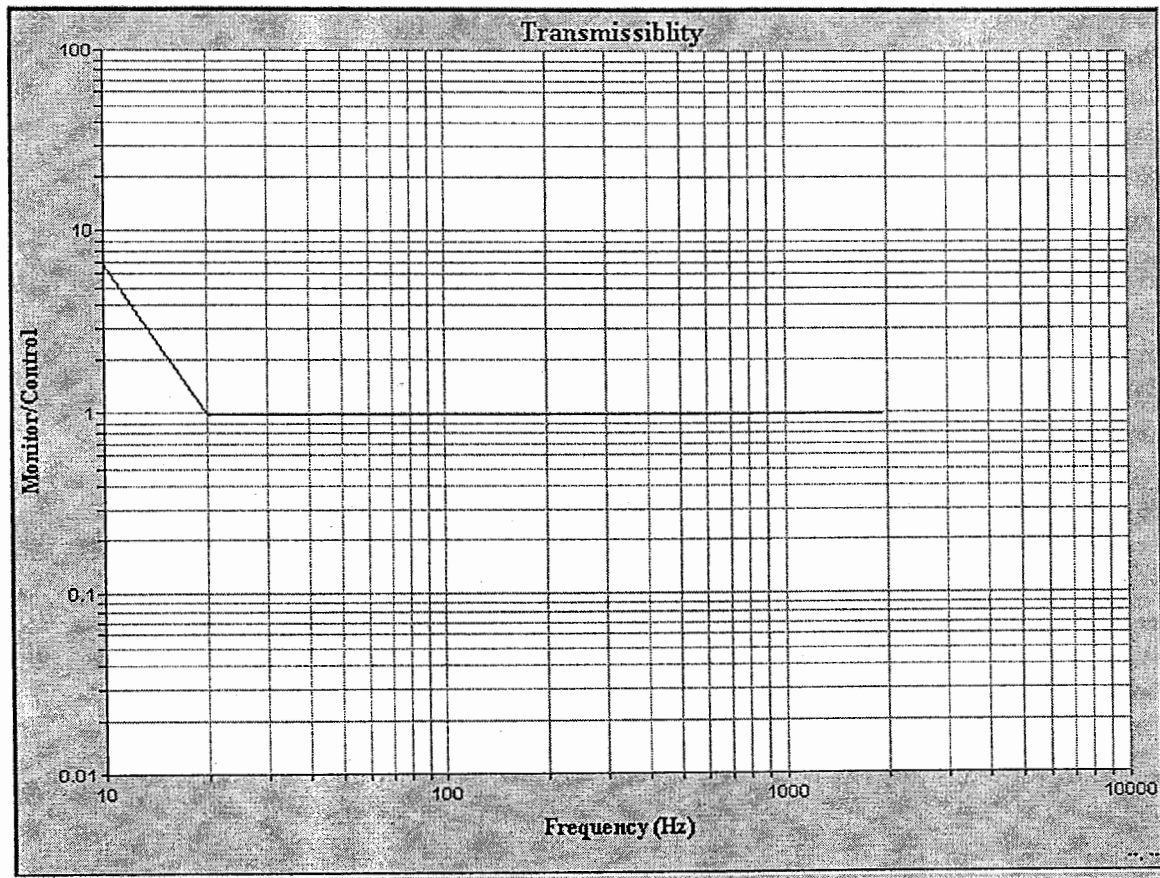
Figure 3-4. Sample Random Mode Transmissibility Graph.
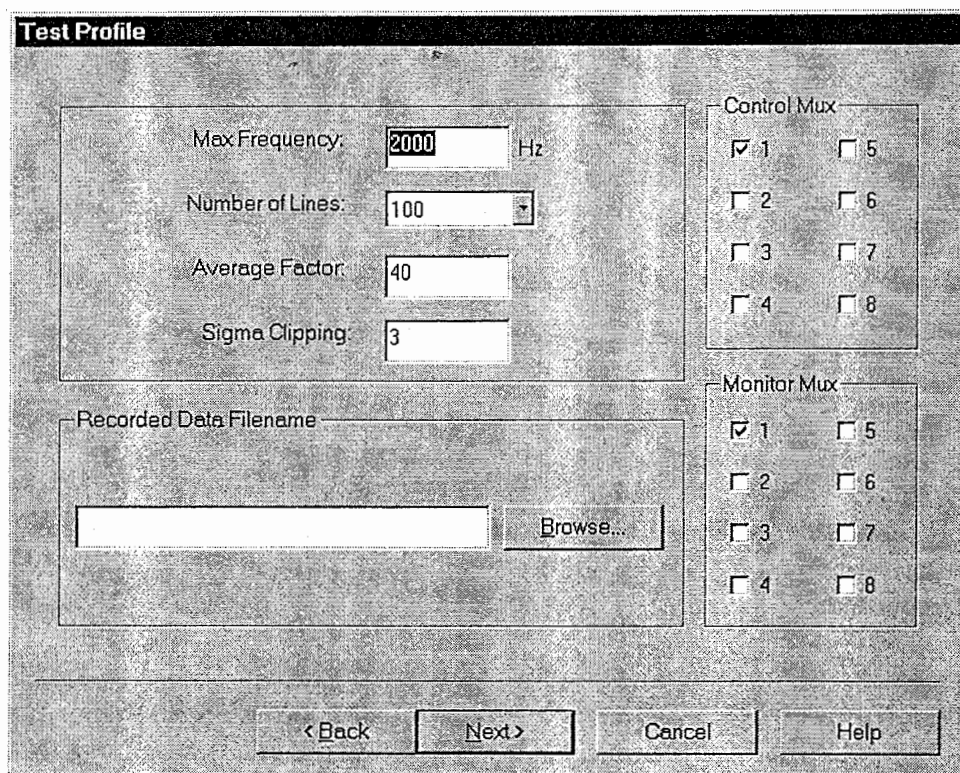
3.2. Defining a New Random Mode Test

WinVCS provides a test definition wizard for each vibration mode. The Random mode wizard takes you sequentially through the Random mode windows, allowing you to define a complete test. Once you define the test, WinVCS loads the test into the WinVCS main window. You can access the same parameter displays and tables through the Options menu's Test Options command.

NOTE: Use the *Save* or *Save as* File menu commands to save the defined test.

To enable the Random mode test wizard:

1. At the WinVCS window, select the **Random** button (![button]).

2. Select the **New Test** button (![button]) to open the Random mode test wizard. See Figure 3-5.

3. The wizard takes you through all the profile definition displays. As you finish editing each window, use the buttons at the bottom of the display to move back and forth through the definition windows to change the fields.

4. Refer to the paragraph 3.2 sub-topics to define a complete test.

Figure 3-5. Random Mode Test Profile Wizard.

3.2.1. Test Profile Displays

The Test Profiles displays allow you to set up the over-all characteristics of the VCS test. See Figure 3-6. Edit the fields as follows:

Figure 3-6. Test Profile parameter displays

Max Frequency Field	Enter the maximum frequency limits of your product or shaker, whichever is less. This sets up the bandwidth of the test. The demand plot will run from 0 Hz to the defined frequency.
Number of Lines Pull-Down List	Choose the number of filter resolution lines that WinVCS will use in the graphic displays. Increase the lines for a slower, more accurate display.

NOTE: The Filter Bandwidth is equal to the Max Frequency setting divided by the Number of Lines setting.

Average Factor Field	Enter the number of frames of data WinVCS will average together before converting the data to a response plot. A larger number provides a slower and smoother response. A smaller number forces WinVCS to convert more data for display, and it provides a more accurate response. The objective is to enter an average factor that displays enough data without dedicating the system to data conversions.
Sigma Clipping Field	This field allows you to clip very large spikes out of the drive plot. WinVCS multiplies the over-all signal Vrms level by the Sigma Clipping entry to determine where it will clip the signal.

For example, a Sigma Clipping value of 3 will clip a 0.8Vrms drive signal whose spikes exceed 2.4 Vpk. The shaker amplifier will not see any portion of this drive signal that exceeds 2.4 Vpk.

Control Mux and Monitor Mux Check boxes

Select the channels that you are using as control and monitor channels.

- WinVCS averages all the selected control inputs together to develop the control response plot.

- WinVCS averages all the selected monitor inputs together to develop the monitor response plot.

Recorded Data Filename Group

This group allows you to define the name of the file being used to record a response. This group is used with both the Record and Play commands of the Stored Data menu to save and retrieve historical plot data. It is also used to save and retrieve external response data.

The **Recorded Data Filename** field displays the file path and name of the stored data file. Enter the exact path and name into the field, or use the Browse button to locate the file.

- The Record and Play commands use this file directly.

- The Stored Data files use the filename, but replace the extension with a generated three-digit number.

The **Browse** button allows you to select the field using the Open window. Always select a record (.rec) file.

3.2.2. Abort Parameters Displays

This screen defines the abort limits of the test. Refer to Figure 3-7. The fields are described below:

Figure 3-7. Abort Parameters.

Control & Monitor Abort Lines

Define how many lines of the frequency resolution the response signal is allowed to cross the abort limits before an abort occurs. The lines, as defined in the Test Profile screen, are vertical lines that are evenly spaced across the frequency bandwidth. Normally, you would not want a stray signal spike to cause an abort. This parameter defines the allowable width of the stray signal or cumulative width of separate stray signals. Note that the Control or Monitor field affects its respective Response Profile only.

Normally, the abort lines are set to five percent of the total lines (e.g., 20 abort lines for 400 lines). For example, NAVMAT1 is programmed with 400 lines and 20 abort control lines. If the control-input channels indicate PSD levels outside the defined Abort ±dB limits at more than 20 lines, the test will abort. If the PSD levels are outside the Abort ±dB limits at 19.999 lines, the test does not abort.

To disable the Abort Lines, set the parameter greater than or equal to the Number of Lines field in the Parameters: Test Profile screen. Then set the corresponding RMS fields to 0.00. In Figure 3-6, the Abort Monitor Lines are disabled.

Control & Monitor Max RMS (dB)

Define the maximum g rms or m/s² rms limits of the Response Profiles. Each field's positive number must be less than the Reference Profile's defined Abort +dB limit. Note that the control field affects the control response and the monitor field affects the monitor response.

Control & Monitor & Min RMS (dB)

Define the minimum g or m/s² rms limits of the Response Profiles. Each field's negative number must be more positive than the Reference Profile's defined Abort -dB limit. Note that the control field affects the control response and the monitor field affects the monitor response.

Max Start RMS

Defines the maximum drive output (Vrms) that WinVCS can generate before it stabilizes at the first scheduled level. If WinVCS never reaches the desired level, it aborts the test.

Max Run RMS

Defines the maximum drive output (Vrms) that WinVCS can generate during a test. If WinVCS cannot reach the desired level, it will abort the test.

Reference Table

The reference table defines the demand plot for the test. See figure 3-8. The demand plot sets the parameters for the desired response from the shaker. Based on this plot, WinVCS develops the drive output to the shaker amplifier, and modifies the drive to maintain a control response that is within the tolerance limits of the test. The table and its controls are described below:

Reference Table

This table defines the demand for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

Note that the table automatically re-sorts by frequency.

New Row Button

Click this button to add a line to the table. Once you edit the line, the table automatically re-sorts by frequency.

Clear Data Button

Click this button to clear all the data from the table.

Import Control and Import Monitor Buttons

Imports the data directly from a saved data file. Import control uses the control data from the Stored Data file as reference, and Import monitor uses the monitor data from the saved data file as reference.

Note: If the stored data file was created with WinVCS version 1.1 or earlier, you must first **VIEW SAVED DATA** (from the **STORED DATA** menu), and then resave the file (**SAVE CURRENT DATA** from the **STORED DATA** menu). The file will be renamed and you may delete the older version.

Frequency Field

Enter a frequency breakpoint within the defined bandwidth where a change in output will occur.

NOTE: The first and last breakpoints determine the bandwidth of the test. Make sure the bandwidth is within the performance specifications of your shaker.

PSD Field

Enter the defined PSD level between two break points.

Slope (dB/Oct) Field

Enter the defined slope between two frequencies. To use this value, set the PSD field to zero on the same or next line. Once you define the test or finish editing the Test Options, WinVCS calculates the PSD for the "zero" field based on the slope.

Enter Button

Click this button to apply the displayed Edit Current Breakpoint parameters to the highlighted line in the Reference table. If you changed the frequency, the table automatically re-sorts the lines by frequency.

Figures 3-8 and 3-9 show a sample reference table and resulting demand plot. ·

1. The breakpoints are located at each end of the plot and at each point of the graph where the slope changes.

2. The slopes consist of each line segment between the breakpoints.

3. The bandwidth runs between 20 Hz and 2000 Hz, the first and last breakpoint frequencies.

4. The bandwidth runs between 20 Hz and 2000 Hz, the first and last break point frequencies.

5. A 3 dB/Oct slope runs between 20 Hz and 80 Hz. The g^2/Hz value at the 20 Hz break point has been automatically calculated.

6. The PSD output is a flat 0.0279 g^2/Hz between the 80 Hz and 350 Hz break points.

7. The PSD output slopes at -3 dB/Oct from 0.0279 g^2/Hz at 350 Hz to a calculated 0.0049 g^2/Hz output at 2000 Hz

Frequency (Hz)	PSD (g^2/Hz)	Slope (dB/Oct)
0.00	0.0000	0.0000
20.00	0.0020	0.0000
40.00	0.0040	0.0000
60.00	0.0055	0.0000
80.00	0.0056	0.0000
100.00	0.0058	0.0000
120.00	0.0078	0.0000
140.00	0.0071	0.0000
160.00	0.0089	0.0000
180.00	0.0070	0.0000
200.00	0.0088	0.0000
220.00	0.0075	0.0000

Import Control   Import Monitor   New Row   Clear Data

Figure 3-8. Reference Table and its Controls
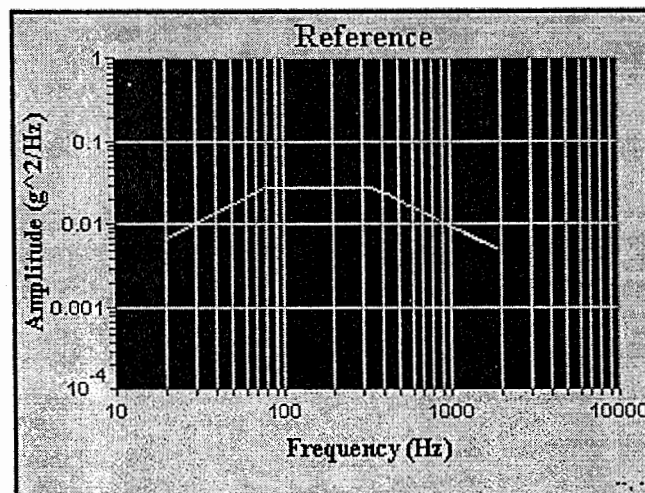
Figure 3-9. Reference Graph.

3.2.4. Control Limits Table

This table defines how far the control-input channels' response profiles can deviate from the demand profile before action must be taken. Refer to Figure 3-10. The table and its controls are described below:

Control Limits Table

This table defines the control response limits for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

Note that the table automatically re-sorts by frequency.

Frequency Field

Enter a frequency breakpoint within the defined bandwidth where a change in the abort and tolerance limits will occur.

NOTE: The first and last breakpoints determine the bandwidth of the test. Make sure the bandwidth is within the performance specifications of your shaker.

Tolerance +dB Field

Enter the tolerance limit above the demand plot in positive units of dB. The control response must stabilize below this limit before the test clock starts. Once the clock starts WinVCS issues a warning any time the control response exceeds the limit, and it adjusts the drive to stay below the limit.

Tolerance –dB Field

Enter the tolerance limit below the demand plot in positive units of dB. The control response must stabilize above this limit before the test clock starts. Once the clock starts, WinVCS issues a warning any time the control response exceeds the limit, and it adjusts the drive to stay below the limit.

Abort +dB Field

Enter the abort limit above the demand plot in positive units of dB. Once the clock starts, WinVCS aborts the test any time the control response crosses the limit as defined in the Abort Parameters screen.

Abort -dB Field

Enter the abort limit below the demand plot in positive units of dB. Once the clock starts, WinVCS aborts the test any time the control response crosses the limit as defined in the Abort Parameters screen.

The reference graph's demand plot, with the defined limits from Figure 3-10, is displayed in Figure 3-11. Note that the limits are in proportion to the demand plot. No matter how the signal changes, the limits stay in the same dB proportion between 20 Hz and 500 Hz. At 500.01 Hz, the limits change. Between 500.01 Hz and 2000 Hz, the limits maintain the same proportion.

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00

Figure 3-10. Control Limits Table
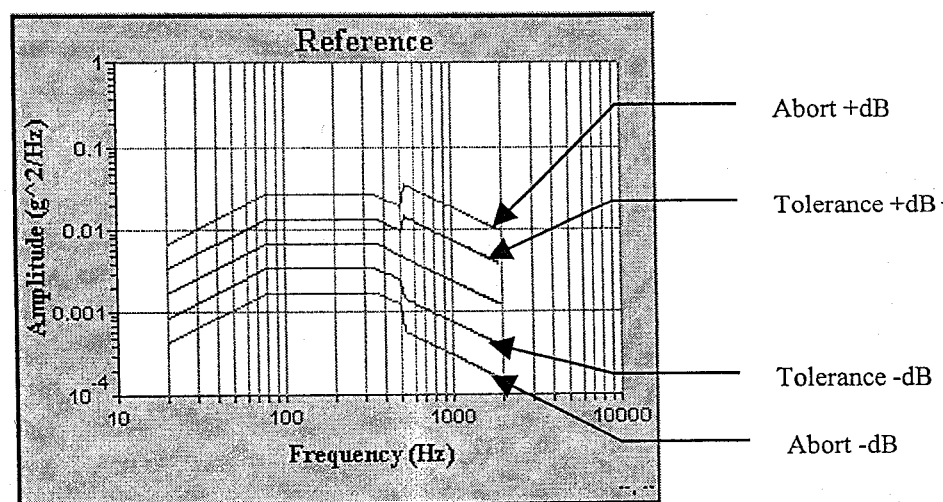
Figure 3-11. Reference Graph with the Defined Control Limits.

3.2.5. Monitor Limits Table

The Monitor Limits table defines how far the monitor-input channels' response can deviate from the demand plot before action must be taken. Refer to Figure 3-12. The table and controls are described below:

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00

☐ Disable Monitor Limits

Figure 3-12. Monitor Limits Table and Controls

Monitor Limits Table This table defines the monitor response limits for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

Note that the table automatically re-sorts by frequency.

Disable Monitor Limits Check Box Click this box to enable (clear) or disable (mark) the monitor limits. If you disable the monitor limits, WinVCS issues warnings or aborts the test based on the control limits alone.

Frequency Field Enter a frequency breakpoint within the defined bandwidth where a change in the abort and tolerance limits will occur.

NOTE: The first and last breakpoints determine the bandwidth of the test. Make sure the bandwidth is within the performance specifications of your shaker.

Tolerance +dB   Enter the tolerance limit above the demand plot in positive units of dB. Once the clock
Field   starts WinVCS issues a warning any time the monitor response exceeds the limit, and it
                     adjusts the drive to stay below the limit.

Tolerance –dB   Enter the tolerance limit below the demand plot in positive units of dB. Once the clock
Field   starts, WinVCS issues a warning any time the monitor response exceeds the limit, and it
                     adjusts the drive to stay below the limit.

Abort +dB   Enter the abort limit above the demand plot in positive units of dB. Once the clock
Field   starts, WinVCS aborts the test any time the monitor response crosses the limit as defined
                     in the Abort Parameters screen.

Abort -dB   Enter the abort limit below the demand plot in positive units of dB. Once the clock
Field   starts, WinVCS aborts the test any time the monitor response crosses the limit as defined
                     in the Abort Parameters screen.

You should program the monitor limits to allow greater deviations from the demand plot than the control
limits, because WinVCS will not adjust its output to compensate if the monitor channel response deviates
outside the monitor limits. If you program tighter limits on the monitor channels, WinVCS could abort the
test before the control response indicates an out-of-tolerance condition.

3.2.6. Level Schedule Table

This table allows you to operate the test at different levels in relation to the reference profile. Refer to
Figure 3-13. Each level runs for a defined time duration before moving to the next level. The table's fields
are defined below:

Level   This table lists all the defined levels for a test. It allows you to operate the test at different
Schedule   levels in relation to the reference profile.
Table
                    • Use the arrow keys to navigate the fields.

                    • Use the **DELETE** key to clear the currently selected row. (select a row by single-
                      clicking any field in the row)

                    • Use the **DELETE** key to clear the currently selected field (select a field by double-
                      clicking it)

                    • Copy data to the Windows clipboard by selecting the data (from this or another
                      spreadsheet) and using the copy function. The initial cells must be in the same layout as
                      the destination cells.

                    • Paste data from the Windows clipboard using the Paste function. Single-click the first
                      field of the destination row before pasting.

                    Note that the table automatically re-sorts by level number.

Duration   Enter the duration of the level's test into the Hours:Minutes:Seconds fields. Once the
Fields   control response is within the tolerance limits of the test, WinVCS starts the test clock from
                    the Duration fields' time settings.

Level	Test Time	dB Level	g rms Level	% Level	Start
1	00:00:00	0.00	0.00	100.00	Normal
2	00:00:00	0.00	0.00	100.00	Normal
3	00:00:00	0.00	0.00	100.00	Normal
4	00:00:00	0.00	0.00	100.00	Normal
5	00:00:00	0.00	0.00	100.00	Normal
6	00:00:00	0.00	0.00	100.00	Normal
7	00:00:00	0.00	0.00	100.00	Normal
8	00:00:00	0.00	0.00	100.00	Normal
9	00:00:00	0.00	0.00	100.00	Normal
10	00:00:00	0.00	0.00	100.00	Normal
11	00:00:00	0.00	0.00	100.00	Normal
12	00:00:00	0.00	0.00	100.00	Normal
13	00:00:00	0.00	0.00	100.00	Normal

Figure 3-13. Random Mode Level Schedule Table.

The next three fields adjust the level of the Demand Profile's output without changing the shape of the test. You can only program one of these fields per level. If you program more than one of these fields per level, the program will accept the leftmost non-zero field as the output value. The fields are listed below:

dB Level Field   Enter the number of dB's below the full test level that WinVCS will run the test.

G (m/s^2) RMS Level Field   Enter the actual g or m/s^2 rms level of the test. The dB Level field must be set to zero (0) to use this field.

NOTE: The Random mode g rms or m/s^2 rms level must fall within the following formula:

$$6825 > (grms\ level)(mV/g)\ or\ 6825 > (m/s^2\ rms\ level)(mV/m/s^2)$$

Where (g rms or m/s^2 rms Level) is the Random Profile g rms or m/s^2 rms level and (mV/g or mV/m/s^2) is the sensitivity of the accelerometer(s).

% Level Field   Enter the percent (0-100) of the demand profile that WinVCS will output. The dB Level and RMS Level fields must be set to zero (0) to use this field.

Start Pull-down List   Choose the Start Mode from the pull-down list:

- **Normal** starts the scheduled test once the full equalization process is completed. WinVCS brings up the drive, equalizing the drive at several points until it reaches full equalization.

- **Model** allows you to save the drive output for the scheduled test. When you run a test, WinVCS looks for a saved drive. If a drive is not available, WinVCS performs a Normal mode start. Once you complete a successful run at that level, press **CTRL + D** to save the drive. Once you save a Model drive, WinVCS will immediately develop the saved drive and equalize from the drive each time it moves to that level..

- **Resume** performs the same function as the Model drive automatically. It saves the drive at the end of a successful run.

Enter Button   Click this button to apply the contents of Edit Current Level Entry fields to the line that is highlighted in the table.

3.3. Editing an Existing Test

Once you define a test, you can modify it as needed to meet the test requirements, or you can create a new test based on the original test. You can perform these modifications in any operating mode (Run, Stop, or Hold). This allows you to edit the test and watch the results of your changes as WinVCS operates the shaker.

Follow these steps to edit an existing test:

1. Make sure the desired test is loaded into the WinVCS window:

    a. The File menu's New Test command loads the new test into the WinVCS window once you finish defining the test.

    b. The File menu's Open Existing Test command loads the desired defined test into the WinVCS window.

2. Select the Test Options command from the Options window. WinVCS opens the Random Control System Properties window. See Figure 3-14. This window provides access to all the displays used to define a Random mode test.

3. To edit the test parameters:

    a. Select the desired tab to bring its displays to the front.

    b. Edit the parameters as described in Defining a New Test.

    c. Repeat steps a and b to edit another display.

    d. Once you are finished, select [OK] to close the window and apply the parameters to the WinVCS window. WinVCS will use the parameters, but it will not save them until you use the Save or Save as command.
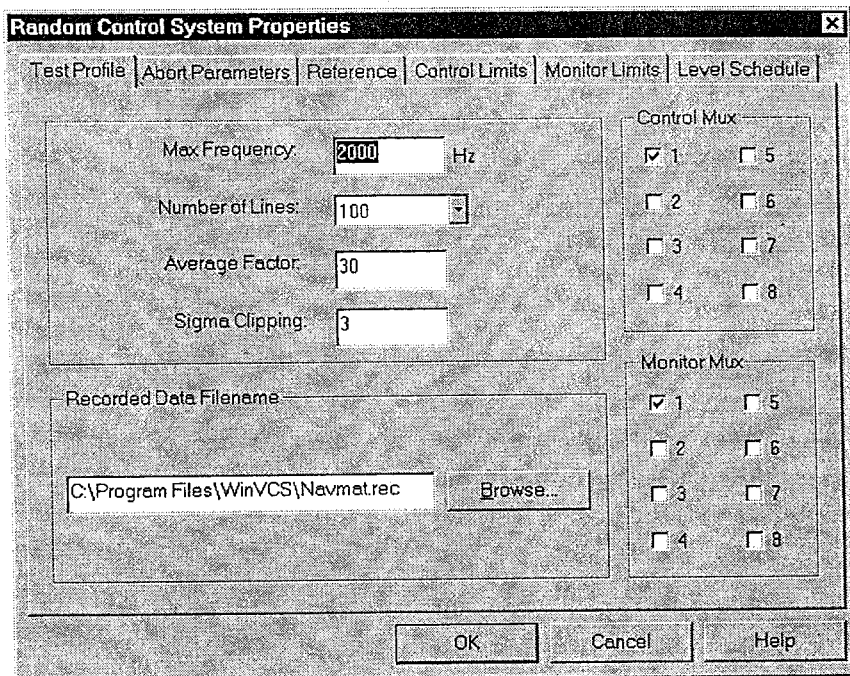
Figure 3-14. Random Control System Properties Window.

    e. If you do not wish to load your changes into the WinVCS window, press [Cancel] to close the window and lose your edits.

4. To save the edits:

    a. Select [💾] to save the test under its original name.

    b. Select **Save as** from the File menu to save the test under a new name.

3.4. Creating an External Profile

The External Profile option allows you to take recorded vibration signals from the field, input the signal through the accelerometer channels, and store it as a data file. Using the test definition functions, you can then specify a stored file to be used as the reference profile. The VCS then converts the data into a demand plot, and uses the limits from the defined profile. The following procedure describes how to input, store, and use the field data to build one or more profiles.

Follow this procedure to create and use an external profile:

1. Select ⬜ to define a new test. The new test wizard opens to the Test Profile display. See Figure 3-15.

2. Set up the following parameters in the Test Profile display:

    a. Enter the maximum frequency you wish to observe in the Max Frequency field.

    b. If needed, modify the average factor for the test.

    c. Select the control and/or monitor channels that will input the external signal(s) from the Control Mux and Monitor Mux check boxes.
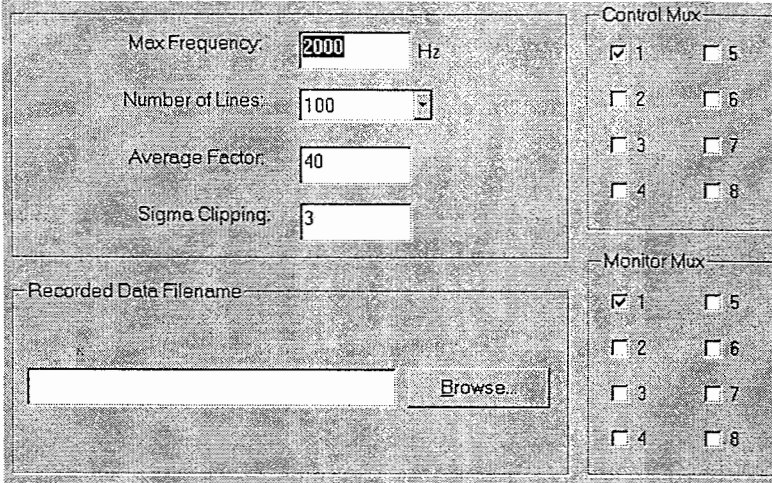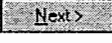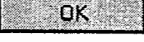
Figure 3-15. Test Profile Display.

    d. Enter the file path and name of the file where you wish to store the extrnal profile into the Recorded Data Filename field. Use the Record (.rec) file externsion.

3. Select ⬛ Next > the number of times needed to exit and load the defined test.

4. Enter the sensitivity of the field accelerometers:

    a. Select the Edit Factors command from the Calibrate menu. WinVCS displays the Edit Factors window. See Figure 3-16.

    b. Enter the sensitivity of the field accelerometers into the accelerometer channels that you are using.

    c. Select ⬛ OK to close the window and save your edits.
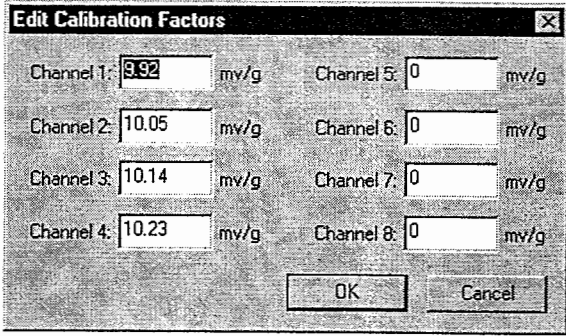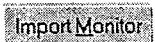
Figure 3-16. Edit Factors Window.

5. To avoid confusion, select the Clear Stored Drives command from the Stored Data menu to clear any stored drives for the defined test.

6. Connect your field source or sources to the input channels defined in step 2.c. Enable the field signals.

7. You may wish to turn off the limit displays on the graph to avoid confusion. Simply right-click the graph and select Show Limits to toggle the lines on or off.

8. Select the External Input command from the Command menu. The Run lamp blinks as WinVCS displays the external signal data in the control and monitor response graphs.

9. Select the Save Current Data command from the Stored Data menu. WinVCS saves the plots to the file defined by the Recorded Data Filename field. Each successive save is written to extension 001,002, 003, ... 999.

10. Select [❌] when you are finished recording the data.

11. Remove the external inputs, and re-connect the original accelerometer inputs from the shaker.

12. Enter the sensitivity of the field accelerometers:

    a. Select the Edit Factors command from the Calibrate menu. WinVCS displays the Edit Factors window. See Figure 3-16.

    b. Enter the sensitivity of the shaker accelerometers into the accelerometer channels that you are using.

    c. Select [OK] to close the window and save your edits.

13. Display the Reference graph on the WinVCS window.

14. Select the Test Options command from the Options menu to display the test. See Figure 3-15.

15. To use the saved external input data as the reference plot:

    a. Select the Reference tab

    b. Select the external input's plot type.

       • Select [Import Control] to import the stored data's control signal plot.

       • Select [Import Monitor] to import the stored data's monitor signal plot.

    c. Select the desired Stored Data file

    d. Select [Open]. The data is imported into the reference table.

16. If needed, go to the other displays in the Test Options window to make other edits. Normally, the default values work well with the tests.

17. Select [OK] to accept the edits and close the window.

18. You can operate and save the External Input profile as you would any other defined test.

3.5. Creating a Random on Random Profile (optional)

The Random Control System allows you to define Random on Random tests by combining a defined Random test with a Random on Random table that defines a set of narrow band Random steps. The following paragraphs describe Random on Random tests and how you set up the Random Control System to run a Random on Random test.

Random on Random is often referred to as Swept Random on Random to better describe the tests. These tests define a flat band background test combined with a set of narrow band steps placed on top of the wide band test. As the wide band test outputs a standard Random demand, the narrow band steps slowly sweep up and down within the frequency band of the demand. As it sweeps through the frequency band, each narrow band step dramatically changes the amplitude level of the demand within the area that it is sweeping. The VCS automatically adjusts tolerance and abort limits, along with other adjustments, to allow the test to continue without being aborted.

With the Random on Random option enabled, the VCS treats the Random test as a Random on Random test. The VCS reads the table, and uses it to superimpose the narrow band steps defined in the table on top of the Random test's wide band PSD demand. The VCS sweeps the narrow band steps up and down the Random profile's frequency band at the sweep rate(s) entered into the table.

3.5.1. Using the Random on Random table

The Random on Random table allows you to enter up to 16 narrow band steps for the Random on Random test. Figure 3-17 shows example narrow band data entered into the Random on Random table.

Figure 3-17. Random on Random table

NOTE: In addition to defining the Random on Random table, you must define the background Random test according to section 3.2 of this manual.

Random on Random table

This table defines up to 16 narrow band steps for the Random on Random test.

- Use the arrow keys to navigate the fields.
- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)
- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function.

- The initial cells must be in the same layout as the destination cells.
- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

Start & Stop

Enter the starting and ending frequency of the narrow band step (in Hz). The Start Band and Stop Band Frequencies define the range of frequencies that the filter for the narrow band step will center on.

Amplitude

Enter the PSD level for the step to reach. This defines the PSD output of the narrow band step.

Bandwidth

Enter the bandwidth of the filter (in Hz). The bandwidth defines the width of the narrow band filter.

Min/Sweep

Enter the sweep speed in minutes per sweep. Band Minutes/Sweep defines how long the band will take to sweep up or down the assigned frequency range.

Section 4
Sine Vibration Mode

4. Overview

The Sine Vibration mode functions allow you to define, edit, run, and view Sine vibration tests. This section describes the Sine Vibration mode graphs, and it provides the procedures for defining and editing Sine mode tests. In addition, its Special Programming and Operating Techniques topic provides operating instructions for special Sine mode functions.

4.1. The Sine Mode Graphs

The Sine mode graphs display the defined test and the real-time closed loop displays during the test. The defined test plots the desired response plot from the shaker. The real-time closed loop graphs show how the system is operating to achieve the desired response:

- The Reference Profile graph plots the acceleration demand plot created by the test definitions.

- The Acceleration, Velocity, and Displacement graphs plot the actual accelerometer readings from the shaker for the three control modes.

- The Drive graph plots the drive signal output to the shaker amplifier.

- The Transmissibility graph plots the response ratio between the monitor and control accelerometer readings.

The following topics describe each type of graph.

4.1.1.   Reference Profile Graph

The Reference Profile graph displays the demand acceleration plot over a defined frequency band. See
Figure 4-1. The demand plot is the center plot of the graph. You define or edit the demand plot from the
Sweep Demand Table window for Sweep mode, and in the Test Profile window for Fixed mode. Both
windows are described later in this section. The demand plot defines the response the closed-loop system is
working to achieve during the test. The demand plot is surrounded by two bands:

- The tolerance band is displayed as the two plot lines that are closest to the demand plot. They display
  the acceptable amplitude limits for the test.

- The abort band is displayed as the two outer plot lines. They display the absolute amplitude limits of
  the test. The test aborts if the response exceeds these limits.
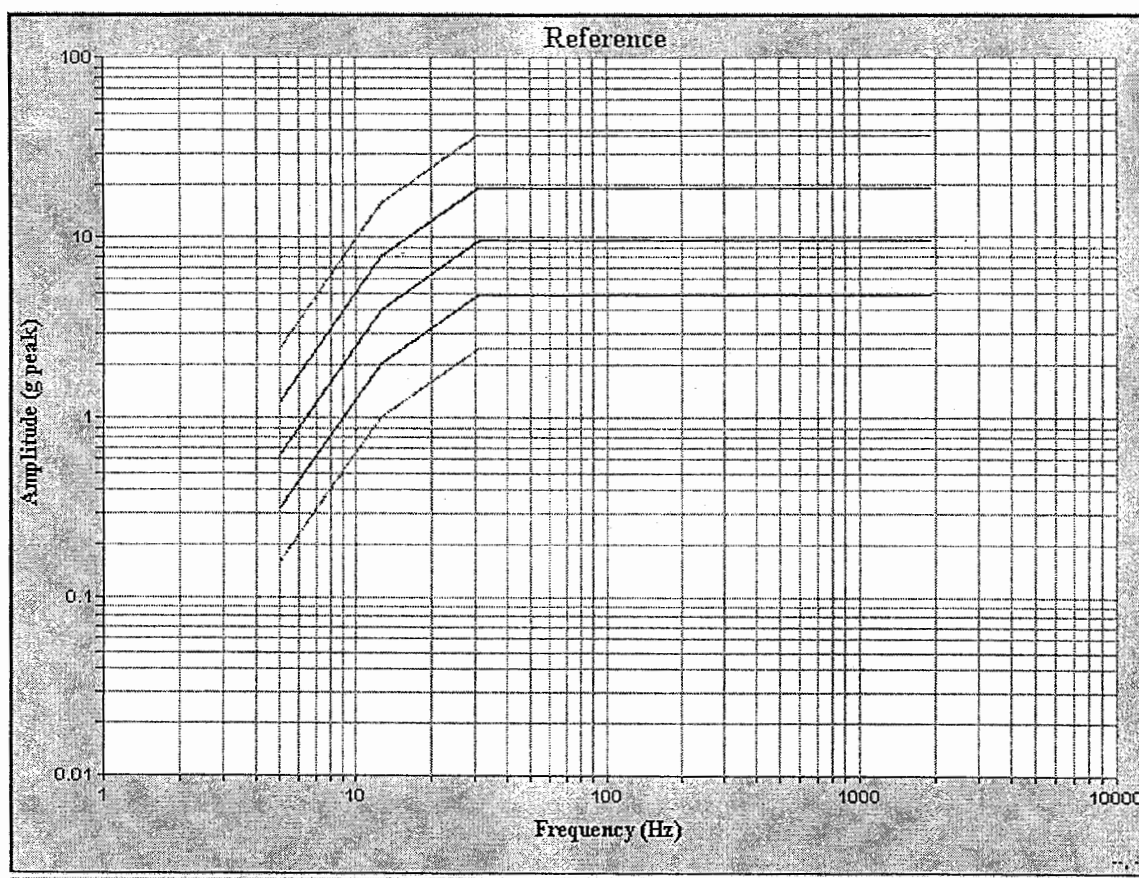
Figure 4-1. Reference Profile Graph.

4.1.2. Acceleration, Velocity, and Displacement Response Graphs

The Control and Monitor Response graphs display actual response from the control and monitor accelerometers that are mounted on the shaker. Figure 4-2 shows the Reference plot and the three control response graphs:

- The Acceleration graphs plot the acceleration response in g's over the defined frequency band.

- The Velocity graphs plot the velocity response in inches per second over the defined frequency band.

- The Displacement graphs display the displacement in inches peak-to-peak over the defined frequency band.

Like the Reference graph, the response graphs can also display the abort and tolerance limits. In addition, the control and monitor accelerometers have their own response graphs for monitoring:

- The Control Response graphs display the response used by WinVCS to adjust its demand output to the shaker. The control response is a part of the closed-loop control system.

- The Monitor Response graphs display the response of other areas around the product or shaker. This response is calculated separately and is not a part of the closed-loop system.
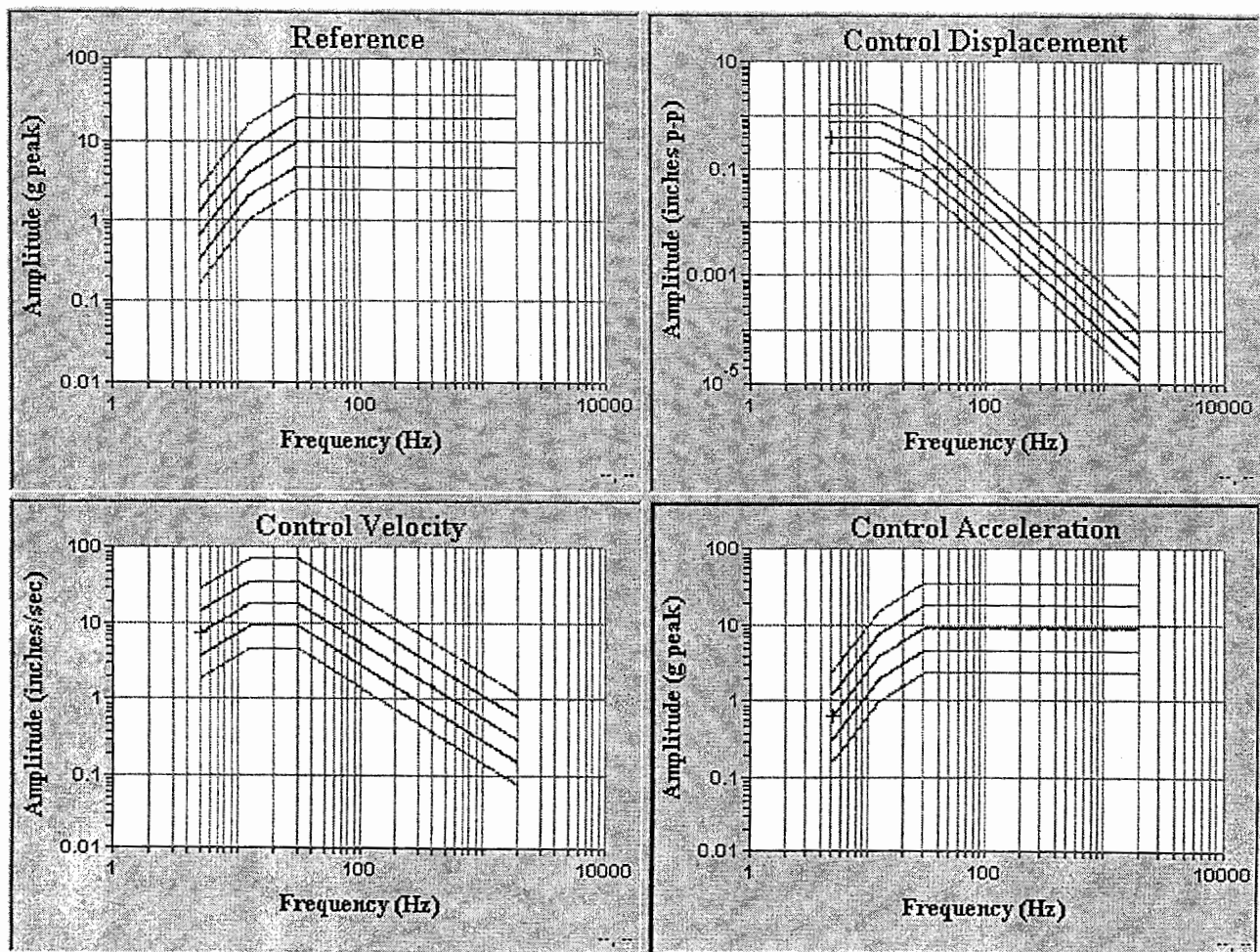
Figure 4-2. The Reference and Response graphs.

4.1.3. Drive Graph

WinVCS plots its actual frequency-domain drive signal output on the Drive graph. See Figure 4-3. The graph shows the amplitude of the drive signal's voltage in decibels over the defined frequency range. WinVCS converts this signal to a time-domain drive signal that is applied to the shaker amplifier through the VCS I/O module.
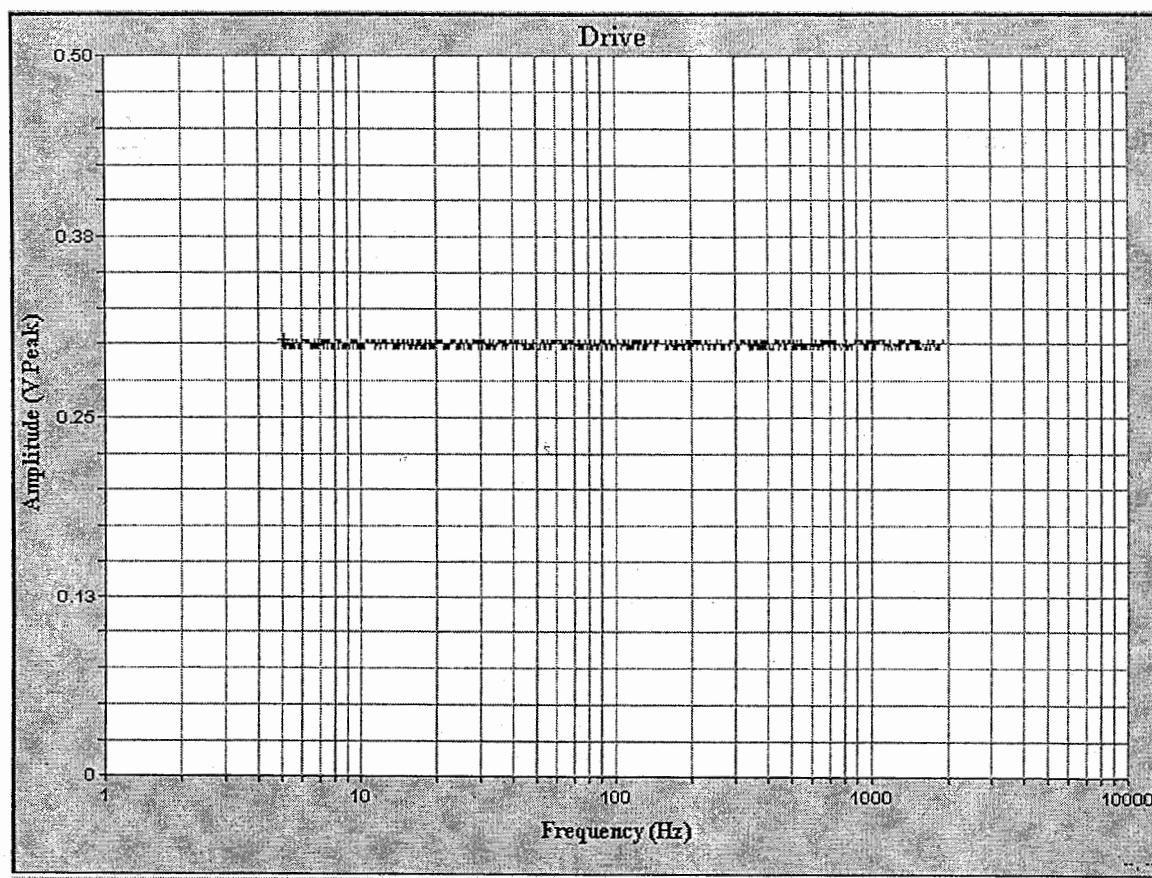
Figure 4-3. Drive Graph.

4.1.4. Transmissibility Graph

The Transmissibility graph displays the response ratio between the monitor and control accelerometers. WinVCS plots the monitor acceleration response (g's) divided by the control acceleration response plot (g's) across the defined frequency band.

You can use this graph to find resonance points on your product. Place the monitor accelerometer on your product and the control accelerometer on your product fixture. As you run a test, observe the ratio between the product and the fixture.
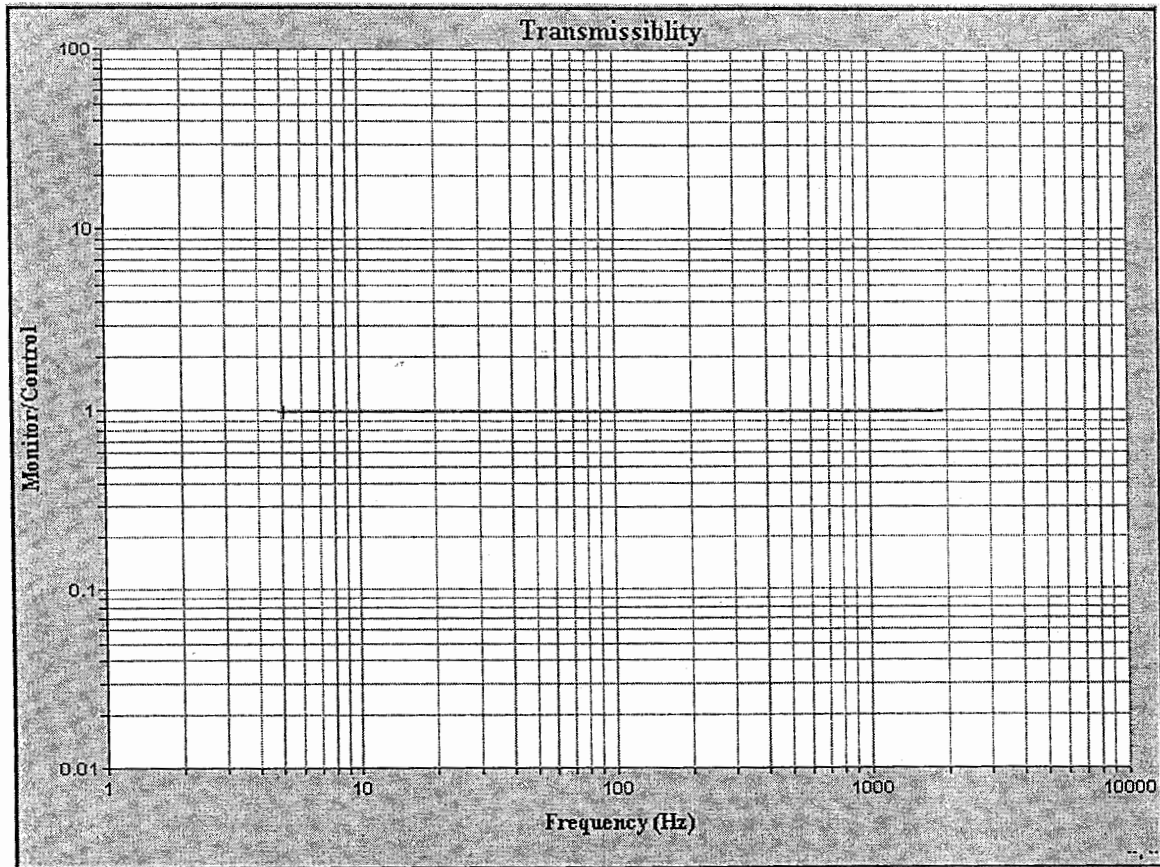
Figure 4-4. Transmissibility Graph.
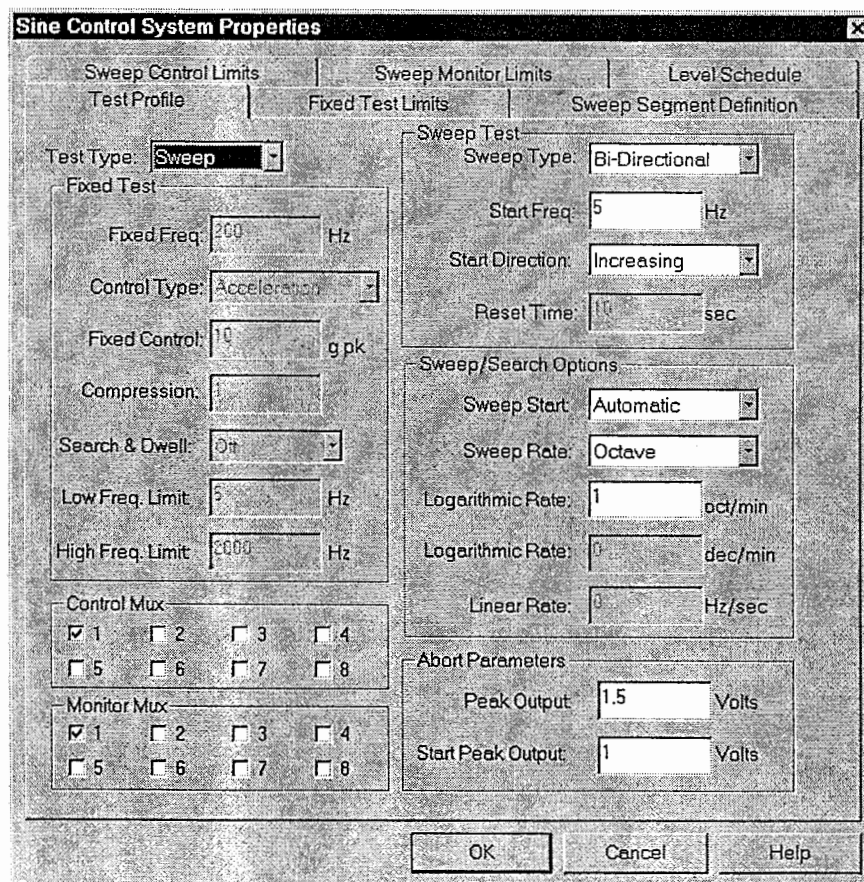
4.2. Defining a New Sweep Test

WinVCS provides a test definition wizard for each vibration mode. The Sine mode wizard takes you sequentially through the Sine mode windows, allowing you to define a complete test. Once you define the test, WinVCS loads the test into the WinVCS main window. You can access the same parameter displays and tables through the Options menu's Test Options command.

NOTE: Use the *Save* or *Save as* File menu commands to save the defined test.

To enable the Sine mode test wizard:

1. At the WinVCS window, select the **Sine** button ( ).

2. Select the **New Test** button ( ) to open the Sine mode test wizard. See Figure 4-5.

3. The wizard takes you through all the profile definition displays for Sine and Fixed modes.

    a. As you finish editing each window, use the buttons at the bottom of the display to move back and forth through the definition windows to change the fields.

    b. You can move past the Fixed Test Limits displays. These parameters apply only to Fixed Frequency tests.

4. Refer to the paragraph 4.2 sub-topics to define a complete Sine Sweep test.

Figure 4-5. Sine Mode Test Profile Wizard.

4.2.1. Test Profile Displays for Sweep Tests

The Test Profile displays allow you to set up the over-all characteristics of the test. See Figure 4-6. The Sweep and general parameters are described as follows.

Test Type Pull-Down List   Choose Fixed or Sweep test from the list.

- Sweep tests move the sine wave up and down a defined frequency band. Select this option for the Sweep tests.

- Fixed tests allow you to define a constant frequency test and the optional Resonance Search and Dwell tests. The Fixed test procedures are described in paragraph 4.3.

The **Sweep Test** group defines the general parameters for a Sweep Test.

Sweep Type Pull-down List   Choose how the test sweeps across the frequency band from the list.

- Bi-directional sweeps the signal back and forth across the frequency band.

- Up sweeps from the lowest frequency to the highest and then starts a new sweep from lowest highest.

- Down sweeps from the Highest frequency to the lowest frequency and then starts a new sweep from highest to lowest.

Sweep Start Pull-down list   Choose the Automatic or Manual start mode from the list.

- Automatic mode brings up the drive signal at the start frequency and then starts sweeping.

- Manual mode brings up the drive at the start frequency and then goes into Hold mode. Use the Run or Resume command to start the sweep.

Start Freq Field   Enter the start frequency of the test in this field. WinVCS will bring up the drive at this frequency and then continue normally from that point onward.

Start Direction Pull-Down List   Choose the start direction of a bi-directional sweep test from the list.

Sweep Rate Pull-down List and Fields   Choose the type of sweep rate from the list. WinVCS enables one of the following fields for editing:

> **Logarithmic Rate (oct/min)** - Enter how many octaves the test will sweep through per minute.

> **Logarithmic Rate (dec/min)** - Enter how many decades the test will sweep through per minute.

> **Linear Rate (Hz/sec)** - Enter how many Hertz the test will sweep through per minute.

Once you enter the value, WinVCS calculates the value in the other two fields.

Reset Time Field   Enter how long in seconds WinVCS will take to re-start at the beginning of an Up or Down sweep. This field is disabled for the Bi-directional Sweep Type.

Figure 4-6. Test Profile Displays with the Sweep Test Type Enabled.

The Control Mux and Abort Parameters groups are common to all Sine tests.

Control Mux
Check Boxes

Mark the box or boxes of the input channel numbers that you are using as control channels. WinVCS will average these inputs together to create the control response plot.

Peak Output
Voltage Field

Enter the maximum peak output voltage limit for the drive signal into this field. If the peak voltage ever exceeds this value during a sine test, WinVCS aborts the test.

Start Peak Output
Field

Enter the maximum peak output voltage the drive signal can achieve without an accelerometer response.

- WinVCS uses this value at the beginning of a test to check for an open loop condition.

- As it develops the drive signal, it checks for a response from the shaker.

- If the drive signal exceed this value before WinVCS detects a response from the accelerometer(s), WinVCS performs a Start Open Loop abort.

4.2.2. Sweep Demand Profile Table

This table defines the demand plot for the test. See figure 4-7. The demand plot sets the parameters for the desired response from the shaker. Based on this plot, WinVCS develops the drive output to the shaker amplifier, and modifies the drive to maintain a control response that is within the tolerance limits of the test. The table and its controls are described below:

Seg #	Start Hz	Stop Hz	Ctrl Value	Ctrl Type	Cmp Rate
1	0.00	0.00	0.00	Acceleration	1.00
2	0.00	0.00	0.00	Acceleration	1.00
3	0.00	0.00	0.00	Acceleration	1.00
4	0.00	0.00	0.00	Acceleration	1.00
5	0.00	0.00	0.00	Acceleration	1.00
6	0.00	0.00	0.00	Acceleration	1.00
7	0.00	0.00	0.00	Acceleration	1.00
8	0.00	0.00	0.00	Acceleration	1.00
9	0.00	0.00	0.00	Acceleration	1.00
10	0.00	0.00	0.00	Acceleration	1.00
11	0.00	0.00	0.00	Acceleration	1.00
12	0.00	0.00	0.00	Acceleration	1.00
13	0.00	0.00	0.00	Acceleration	1.00

Figure 4-7. Sweep Demand Profile Table and Controls.

Demand Profile Table

This table defines the demand for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

NOTE: The table automatically re-sorts by segment number.

Segment # Field

The sequential number of the frequency segment.

- The frequency segment is a defined portion of the frequency band between breakpoints.

- Each segment starts at the frequency where the preceding segment ended.

Start Freq and Stop Freq Fields

These fields define the breakpoints within the frequency bandwidth where a change in output will occur. The first Start Frequency and the last Stop Frequency defines the bandwidth.

WinVCS can automatically calculate the frequencies between the first segment's Start Frequency and the last segment's Stop Frequency:

- Enter the Start Frequency for segment 1.

- Enter the Stop Frequency for the final segment.

- Enter a zero into all other Start Frequency and Stop Frequency fields.

WinVCS will calculate the Stop and Start frequencies based on the Control Value and Control Type fields for each segment.

- When you finish defining a test or finish editing a test, exit using the Finish or OK button.

- When you open the test again, WinVCS displays all the calculated frequency breakpoints.

Control Value Field and Control Type Pull-down List

These selections allow you to define the control being applied to each segment:

1. Select the type of control (Acceleration, Velocity, or Displacement) from the Control Type pull-down list:

2. Enter the units of the selected type into the Control Value field.

Compression Rate Field

Enter a value to define how fast WinVCS reacts to a change in response.

- This value defines how often WinVCS updates the graphs for the display and adjusts the drive output to stay within the control limits.

- The scale starts at the slowest rate (.1) and ends at the fastest rate (100).

Enter Button

Click this button to apply the displayed Edit Current Breakpoint parameters to the highlighted line in the Reference table.

Control Value Units Table

Current control value units, based on the selected system (SI or US).

4.2.3. Sweep Control Limits Table

This table defines how far the control-input channels' response profiles can deviate from the demand profile before action must be taken. Refer to Figure 4-8. The table and its controls are described as follows:

Control Limits Table   This table defines the sweep control limits for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

NOTE: The table automatically re-sorts by frequency.

Frequency Field   Enter a frequency breakpoint within the defined bandwidth where the abort and tolerance limits change.

Tolerance +dB Field   Enter the tolerance limit above the reference plot in positive units of dB. The control response must stabilize below this limit before the test clock starts. WinVCS issues a warning any time the response plot crosses the limit.

Tolerance -dB Field   Enter the tolerance limit below the reference plot in positive units of dB. The control response must stabilize above this limit before the test clock starts. WinVCS issues a warning any time the response plot crosses the limit.

Abort +dB Field   Enter the abort limit above the reference plot in positive units of dB. Once the test starts, WinVCS aborts the test if the control response plot crosses the limit as defined in the Test Profile screen.

Abort -dB Field   Enter the abort limit below the reference plot in positive units of dB. Once the test starts, WinVCS aborts the test if the control response plot crosses the limit as defined in the Test Profile screen.

Enter Button   Click this button to apply the displayed Edit Current Breakpoint parameters to the highlighted line in the Sweep Control Limits table. If you changed the frequency, the table automatically re-sorts the lines by frequency.

The reference graph's demand plot, with the defined limits from Figure 4-8, is displayed in Figure 4-9. Note that the limits are in proportion to the demand plot. No matter how the signal changes, the limits stay in the same dB proportion throughout the test.

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00

Figure 4-8. Sweep Control Limits Table.
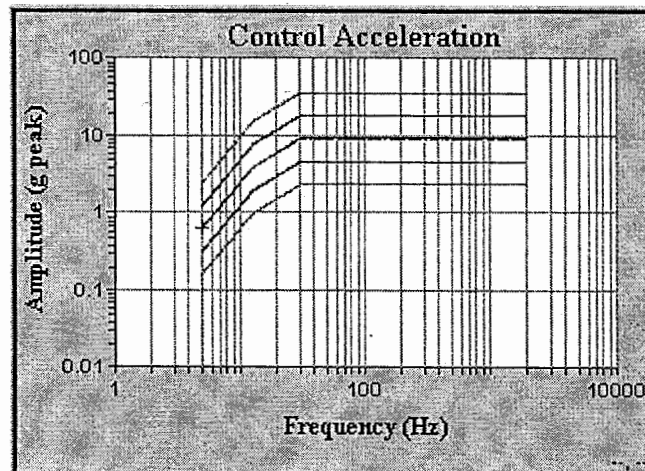
Figure 4-9. Sweep Control Acceleration Graph.

4.2.4. Monitor Limits Table

The Monitor Limits table defines how far the monitor-input channels' response can deviate from the demand plot before action must be taken. Refer to Figure 4-10. The table and controls are described below:

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00
0.00	3.00	3.00	6.00	6.00

☐ Disable Monitor Limits

Figure 4-10. Sweep Monitor Limits Screen.

Control Limits Table

This table defines the sweep monitor limits for the test.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

NOTE: The table automatically re-sorts by frequency.

Disable Monitor Limits Check Box

Click this box to enable (clear) or disable (mark) the monitor limits. If you disable the monitor limits, WinVCS issues warnings or aborts the test based on the control limits alone.

Frequency Field

Enter a frequency breakpoint within the defined bandwidth where the abort and tolerance limits change.

Tolerance +dB Field	Enter the tolerance limit above the reference plot in positive units of dB. The monitor response must stabilize below this limit before the test clock starts. WinVCS issues a warning any time the response plot crosses the limit.
Tolerance -dB Field	Enter the tolerance limit below the reference plot in positive units of dB. The monitor response must stabilize above this limit before the test clock starts. WinVCS issues a warning any time the response plot crosses the limit.
Abort +dB Field	Enter the abort limit above the reference plot in positive units of dB. Once the test starts, WinVCS aborts the test if the monitor response plot crosses the limit as defined in the Test Profile screen.
Abort -dB Field	Enter the abort limit below the reference plot in positive units of dB. Once the test starts, WinVCS aborts the test if the monitor response plot crosses the limit as defined in the Test Profile screen.
Enter Button	Click this button to apply the displayed Edit Current Breakpoint parameters to the highlighted line in the Sweep Monitor Limits table. If you changed the frequency, the table automatically re-sorts the lines by frequency.

4.2.5. Level Schedule Table

This table allows you to operate the test at different levels in relation to the reference profile. Refer to Figure 4-11. Each level runs for the defined time duration before moving to the next level. The table's fields are defined below:

Level Schedule Table	This table lists all the defined levels for a test. It allows you to operate the test at different levels in relation to the reference profile. • Use the arrow keys to navigate the fields. • Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row) • Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it) • Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells. • Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting. Note that the table automatically re-sorts by level number.
Duration Fields	Enter the duration of the level's test into the Hours:Minutes:Seconds fields. Once the selected control response is within the tolerance limits of the test, WinVCS starts the test clock from the Duration fields' time settings.
Num Cycles Field	Enter the number of times the **Sweep** test level must repeat itself before the test moves to the next level. You must set the Test Time to 00:00:00 to use this field. This field is not used during **Fixed Frequency** tests.

Level	Test Time	# Cycles	dB Level	% Level
1	00:00:00	0	0.00	100.00
2	00:00:00	0	0.00	100.00
3	00:00:00	0	0.00	100.00
4	00:00:00	0	0.00	100.00
5	00:00:00	0	0.00	100.00
6	00:00:00	0	0.00	100.00
7	00:00:00	0	0.00	100.00
8	00:00:00	0	0.00	100.00
9	00:00:00	0	0.00	100.00
10	00:00:00	0	0.00	100.00
11	00:00:00	0	0.00	100.00
12	00:00:00	0	0.00	100.00
13	00:00:00	0	0.00	100.00

Figure 4-11. Test Schedule Table.

dB Level Field
Enter the number of decibels (g's peak) below the full test level that WinVCS will run the test.

% Level Field
Enter the percent (0-100) of the demand profile that WinVCS will output. The dB Level field must be set to zero (0) to use this field.

Enter Button
Click this button to apply the contents of Edit Current Level Entry fields to the line that is highlighted in the table.

4.3. Defining a New Fixed Frequency or Search and Dwell Test

WinVCS provides a test definition wizard for each vibration mode. The Sine mode wizard takes you sequentially through the Sine mode windows, allowing you to define a complete test. Once you define the test, WinVCS loads the test into the WinVCS main window. You can access the same parameter displays and tables through the Options menu's Test Options command.

NOTE: Use the *Save* or *Save as* File menu commands to save the defined test.

To enable the Sine mode test wizard:

5. At the WinVCS window, select the **Sine** button ( ).

6. Select the **New Test** button ( ) to open the Sine mode test wizard. See Figure 4-12.

7. The wizard takes you through all the profile definition displays for Sine and Fixed modes.

   a. As you finish editing each window, use the buttons at the bottom of the display to move back and forth through the definition windows to change the fields.

   b. You can move past the Sweep displays. These parameters apply only to Sweep tests.

8. Refer to the paragraph 4.3 sub-topics to define a complete Fixed Frequency or Search and Dwell test.

9. See the Special Programming and Operating Techniques topic in this section for detailed instructions on developing and running a Resonance Search and Dwell test.

4.3.1. Test Profile Displays for Fixed Frequency or Search and Dwell Tests

The Test Profile displays allow you to set up the over-all characteristics of the test. See Figure 4-12. The Sweep and general parameters are described as follows.

Test Type Pull-Down List   Choose Fixed or Sweep test from the list.

- Fixed tests allow you to define a constant frequency test and the optional Resonance Search and Dwell tests. Select this option for the Fixed tests.

- Sweep tests move the sine wave up and down a defined frequency band. The Sweep test procedures are described in paragraph 4.2.

The Fixed Test group displays allow you to enter the basic parameters for a Fixed Frequency or Search and Dwell test.

Fixed Freq Field   Enter the frequency (Hz) of the sine wave into this field. Make sure the frequency is within the specifications of your shaker.

Control Type Pull-down List   Choose the variable (acceleration, velocity, or displacement) that WinVCS will hold constant during the test from the list. During the test, WinVCS controls this parameter at a fixed level and calculates the other two parameters.

Figure 4-12. Sine Test Wizard with the Test Profile displays.

Fixed Control Field	Enter the fixed value of the selected control type (acceleration, displacement, or velocity) in this field using the following scales:

- Acceleration in g's or m/s^2 peak

- Velocity in inches/second or millimeters/second

- Displacement in inches peak-to-peak or millimeters peak-to-peak

During the test, WinVCS controls the test at this value at the fixed frequency.

Compression Field   Enter a value that affects how fast WinVCS reacts to a change in response.

- This value affects how often WinVCS updates the graphs for the display and adjusts the drive output to stay within the control limits.

- The scale starts at the slowest rate (.1) and ends at the fastest rate (100).

Search & Dwell Pull-down List	Choose On or Off from the list.
	• Off enables standard fixed testing.
	• On enables the optional Resonance. Search and Dwell test. This test allows WinVCS to find the resonant frequency of the product load and then dwell on the resonant frequency as a fixed sine wave test.
	See *Running Resonant Search and Dwell* at the end of this section for more details.
Low Freq Limit Field	During a Resonance Search and Dwell test, enter the low frequency limit of the resonance search into this field.
High Freq Limit Field	During a Resonance Search and Dwell test, enter the high frequency limit of the resonance search into this field.

The Control Mux and Abort Parameters groups are common to all Sine tests.

Control Mux Check Boxes	Mark the box or boxes of the input channel numbers that you are using as control channels. WinVCS will average these inputs together to create the control response plot.
Peak Output Voltage Field	Enter the maximum peak output voltage limit for the drive signal into this field. If the peak voltage ever exceeds this value during a sine test, WinVCS aborts the test.
Start Peak Output Field	Enter the maximum peak output voltage the drive signal can achieve without an accelerometer response.
	• WinVCS uses this value at the beginning of a test to check for an open loop condition.
	• As it develops the drive signal, it checks for a response from the shaker.
	• If the drive signal exceed this value before WinVCS detects a response from the accelerometer(s), WinVCS performs a Start Open Loop abort.

4.3.2. Fixed Test Limits Displays

The Fixed Test Limits displays define how far the control and monitor response signals can limits can deviate from the demand plot before action must be taken. See Figure 4-13. The displays are described below.

Figure 4-13. Fixed Test Limits Displays.

Max Control Tolerance Field

Enter the tolerance limit in decibels above the reference plot.

- Enter a positive number.

- The control response plot must stabilize below this limit before the test starts.

- WinVCS displays a warning each time the control response plot crosses the limit.

Min Control Tolerance Field

Enter the tolerance limit in decibels below the reference plot.

- Enter a positive number.

- The response plot must stabilize above this limit before the test starts.

- WinVCS displays a warning each time the response plot crosses the limit.

Max Control Abort Field

Enter the abort limit in decibels above the reference plot.

- Enter a positive number.

- Once the test starts, WinVCS aborts the test if the control response plot exceeds the limit.

Min Control Abort Field	Enter the abort limit in decibels below the reference plot.
	• Enter a positive number.
	• Once the test starts, WinVCS aborts the test if the control response plot crosses the limit.
Max Monitor Tolerance Field	Enter the tolerance limit in decibels above the reference plot.
	• Enter a positive number.
	• The control response plot must stabilize below this limit before the test starts.
	• WinVCS displays a warning each time the control response plot crosses the limit.
Min Monitor Tolerance Field	Enter the tolerance limit in decibels below the reference plot.
	• Enter a positive number.
	• The monitor response plot must stabilize above this limit before the test starts.
	• WinVCS displays a warning each time the monitor response plot crosses the limit.
Max Monitor Abort Field	Enter the abort limit in decibels above the reference plot.
	• Enter a positive number.
	• Once the test starts, WinVCS aborts the test if the monitor response plot exceeds the limit.
Min Monitor Abort Limits Field	Enter the abort limit in decibels below the reference plot.
	• Enter a positive number.
	• Once the test starts, WinVCS aborts the test if the monitor response plot crosses the limit.

4.3.3. Level Schedule Table

WinVCS uses the same Level Schedule table for Sweep and Fixed Frequency tests. See page 4-14 for the Level Schedule instructions.

4.4. Editing an Existing Test

Once you define a test, you can modify it as needed to meet the test requirements, or you can create a new test based on the original test. You can perform these modifications in any operating mode (Run, Stop, or Hold). This allows you to edit the test and watch the results of your changes as WinVCS operates the shaker.

Follow these steps to edit an existing test:

1. Make sure the desired test is loaded into the WinVCS window:

    a. The File menu's New Test command loads the new test into the WinVCS window once you finish defining the test.

    b. The File menu's Open Existing Test command loads the desired defined test into the WinVCS window.

2. Select the Test Options command from the Options window. WinVCS opens the Sine Control System Properties window. See Figure 4-14. This window provides access to all the displays used to define a Sine mode test.

3. To edit the test parameters:

    a. Select the desired tab to bring its displays to the front.

    b. Edit the parameters as described in defining a New Test.

    c. Repeat steps a and b to edit another display.

    d. Once you are finished, select [OK] to close the window and apply the parameters to the WinVCS window. WinVCS will use the parameters, but it will not save them until you use the Save or Save as command.

    e. If you do not wish to load your changes into the WinVCS window, press [Cancel] to close the window and lose your edits.

4. To save the edits:

    a. Select [💾] to save the test under its original name.

    b. Select **Save as** from the File menu to save the test under a new name.

Figure 4-14. Sine Control System Properties Window

4.5. Special Programming and Operating Techniques

The Sine Control System software provides powerful tools that allow you to control and view your system. The following paragraphs describe how to perform some of the special programming and operating procedures.

4.5.1. Graphing a Response Plot of Your Shaker's Armature

An armature response plot graphs the characteristics of the armature as the Drive passes through the shaker's frequency band. The first armature response plot shows you how the armature responds normally. Later, if your shaker is experiencing a loss of performance, you can plot the armature response and compare it to the original response. If they are dramatically different, damage may have occurred on or around the armature.

Follow this procedure to plot the armature response.

1. Make sure the channel 1 accelerometer is installed in one of these locations:

    a. For 16" and 24" armatures, install the channel 1 accelerometer on one of the UNC bolts at the 16" diameter pattern.

    b. For 12" armatures, install the channel 1 accelerometer on one of the UNC bolts at the 12" diameter pattern.

2. Use the New Test (**Ctrl + N**)command to set up a test as follows:

    a. Use the Test Profile display to enter the following parameters:

        •   Test Type = Sweep

        •   Sweep Type = Bi-directional

        •   Sweep Start = Manual

        •   Start Frequency = 200.00 Hz

        •   Start Direction = Decreasing

        •   Sweep Rate = Octave Log rate, 1 octave per minute

        •   Control Mux = Channel 1 only

        •   Peak Output = 6 volts

        •   Start Peak Output = 2 volts

    b. Use the Sweep Demand Profile display to define one segment with the following parameters:

        •   Start Frequency = 20.00 HZ.

        •   Stop Frequency = 2000.00 Hz (3000.00 Hz for DS-2000 shakers)

        •   Control Value = 3.0 g's (29.4 m/s^2) peak

        •   Control Type = Acceleration

    c.   Use the Level Schedule display to enter one level with these parameters:

- Test Time = 00:00:00

- Number Cycles = 2

- dB level = 0.00

- % Level = 100

3. Set up the Control Accelerometer graph properties as follows:

- X & Y Axis Scales = LOG

- X Axis Minimum = 1.00 Hz

- X Axis Maximum = 2000 Hz (3000 Hz for DS-2000 shakers)

- Y Axis Minimum = 0.001 g^2/Hz (0.0960 $(m/s^2)^2$/Hz)

- Y Axis Maximum = 1 g^2/Hz (96.04 $(m/s^2)^2$/Hz)

4. Select the Properties command from the Graph menu, and select the **Auto Save Data** check box

5. Run the test. The test should start up at 200 Hz and then go into Hold.

6. Select **Control Servo Fixed** from the Options menu. A check mark sets the output drive to a fixed voltage.

7. Run the test.

8. Display the Control Acceleration graph. The signal should sweep down to 20 Hz, sweep up to 2000 (or 3000) Hz, sweep back down to 20 Hz, and then stop.

9. Use the Print command to send a plot of the displayed graph to a printer or plotter.

10. The plot is now stored under the file name of your test, followed by a three-digit extension.

11. Once you finish running the test, go into the Options menu and remove the check mark from the **Control Servo Fixed** command.

4.5.2. Programming a Swept Sine Step Change Test

WinVCS requires special programming procedures to perform a Swept Sine Step Change test. The During a Swept Sine test, WinVCS changes acceleration levels almost instantaneously. This can cause the test to abort when the response input from the shaker changes more slowly than the abort lines. This procedure describes how to open the Tolerance and Abort limits enough to continue the test.

A Swept Sine Step Change test programs one or more step changes in the acceleration somewhere in the middle of the sweep. A step change shifts the demand from one acceleration level to another while at the same frequency. Figure 4-15 shows a basic step change entry for the Breakpoints: Frequency & Level screen:

Seg #	Start Hz	Stop Hz	Ctrl Value	Ctrl Type	Cmp Rate
1	5.00	50	2.5	Acceleration	1.00
2	50	150	1.2	Acceleration	1.00

Figure 4-15. Step Change Entry.

Figure 4-15 shows a step change at 50 Hz. Segment 1 sets acceleration at 2.5 acceleration peak between 5 Hz and 50 Hz. Segment 2 drops the acceleration to 1.2 acceleration peak between 50 Hz and 150 Hz. The step is at 50 Hz.

During this step change, WinVCS drops the peak demand to a lower level. If the limits are programmed incorrectly, they drop immediately as well. Figure 4-16 shows the incorrect limits as programmed in the Sweep Control Limits screen. With the limits set at a constant 3 dB and 6dB, the limits change with the acceleration. No matter which sweep direction the signal is heading, the acceleration response signals change more slowly. The slower change causes the response signals to cross the abort lines and abort the test.

You must adjust your Sweep Control Limits (and Monitor) screen to adjust for the slower analog Response signal from the shaker. Refer to Figure 4-17. As shown in the graph, the adjustment serves two purposes:

- It moves the Tolerance and Abort limits enough to allow for the slower response signal.

- It provides a more readable graph.

Follow this procedure to program the proper breakpoint limits.

1. Use this formula to find the difference (x dB) between the two acceleration peak outputs (N1 & N2):

$$|20 \text{ Log } (N1/N2)| = x \text{ dB}$$

   a. In Figure 4-17, the two acceleration control values are 2.5 and 1.2. The difference would be the following formula.:

$$|20 \text{ Log}(2.5/1.2)| = 6.3752 \text{ dB}$$

   b. Use the x dB value (rounded to the nearest tenth) to adjust the dB levels (i.e., 6.4 dB).

2. Determine how far up and down the frequency band you need to move your limits to adjust for the response, establishing a frequency bandwidth through which the analog response signal is allowed sweep:

   a. To adjust the limits, you must try different limits, and watch the Response on the view screen. The object is to come up with limits that allow for the shaker's response time while providing adequate signal limits. You need five frequency breakpoints: two for the abort limits, two for the tolerance limits, and one for the Demand.

Seg #	Start Hz	Stop Hz	Ctrl Value	Ctrl Type	Cmp Rate
1	5.00	50	2.5	Acceleration	1.00
2	50	150	1.2	Acceleration	1.00

Sweep Demand Table

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
5.00	3.00	3.00	6.00	6.00
150.00	3.00	3.00	6.00	6.00

Sweep Control Limits Table
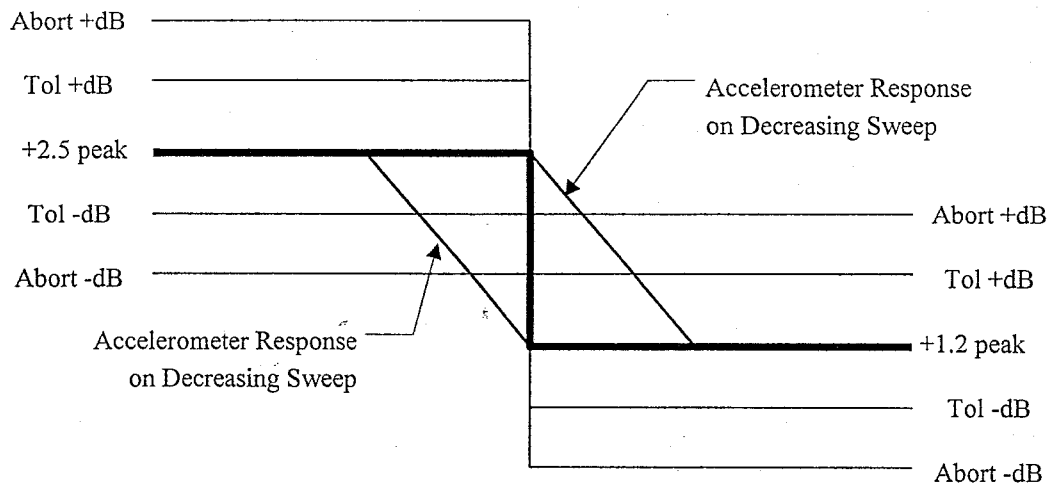
Figure 4-16. Swept Sine Step change with Incorrect Limits.

b.   In Figure 4-17, the limits from the Breakpoints: Control Limits screen are adjusted by 10 Hz each.

- Abort -dB drops 20 Hz early at 30 Hz, followed by Tolerance -dB at 40 Hz.

- The Demand falls in the middle at 50 Hz.

- Tolerance +dB drops 10 Hz late at 60 Hz, followed by Abort +dB at 70 Hz.

3.   Insert the five frequencies determined in step 2 as five sequential breakpoint lines. Start with the lowest frequency and go sequentially to the highest frequency. Note that the five frequencies are inserted between the original breakpoint lines. See Figure 4-17.

4.   Use the difference found in step 1 to program the five frequency breakpoints as shown in Figure 4-17:

a.   Add the difference to Abort -dB on the first frequency.

b.   Add the difference to Tolerance -dB and Abort -dB on the second frequency breakpoint.

c.   Add the difference to Tolerance +dB and Abort +dB on the third frequency breakpoint. (The third breakpoint occurs at the step change frequency.) Return the Tolerance -dB and Abort -dB to their normal levels (i.e., 3 dB and 6 dB on Figure 4-17).

d.   Return Tolerance +dB to its normal level on the fourth frequency breakpoint. Add the difference to Abort +dB.

Seg #	Start Hz	Stop Hz	Ctrl Value	Ctrl Type	Cmp Rate
1	5.00	50	2.5	Acceleration	1.00
2	50	150	1.2	Acceleration	1.00

Sweep Demand Table

Frequency	Tol +dB	Tol -dB	Abort +dB	Abort -dB
5.00	3.00	3.00	6.00	6.00
30.00	3.00	3.00	6.00	12.40
40.00	3.00	9.40	6.00	12.40
50.00	9.40	3.00	12.40	6.00
60.00	3.00	3.00	12.40	6.00
70.00	3.00	3.00	6.00	6.00
150.00	3.00	3.00	6.00	6.00

Control Limits Sweep Table
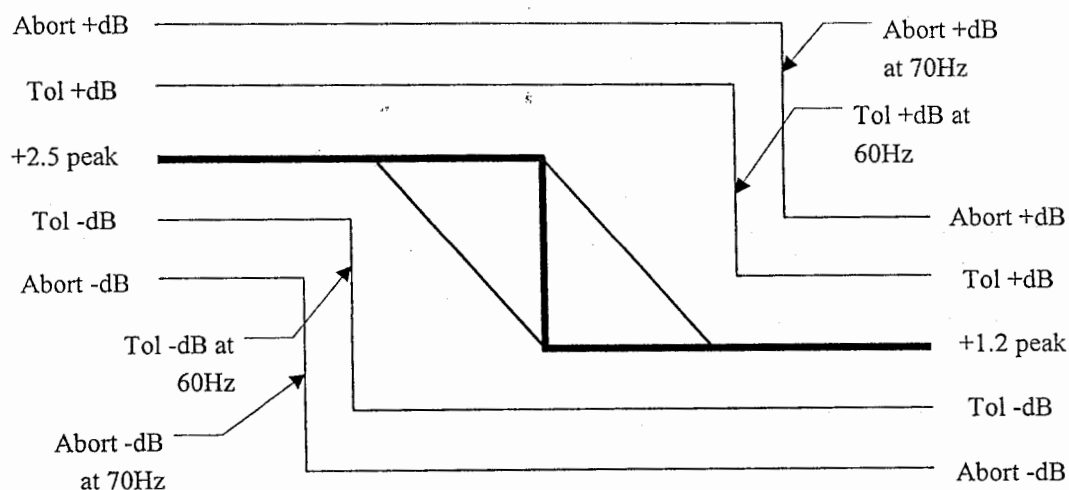
Figure 4-17. Swept Sine Step Change Test with Correct Limits.

   e.   Return all values to their normal limits on the fifth column.

5.   Run the test. The only value you may have to adjust is the breakpoint frequencies. If the test aborts at breakpoint, widen the bandwidth determined in step 2. If the frequencies are too wide, shorten the bandwith.

4.5.3. Running Resonance Search and Dwell

The Resonance Search and Dwell (RSD) feature allows WinVCS to find the resonant frequency of the product load and dwell at that frequency using a fixed sine wave test. This test allows you to test your products at their resonant frequencies to see if these areas are defective or to see how the products react.

RSD compares the control channel to the monitor channel to detect the highest transmissibility peak between the two channels. Normally, the two channels maintain a constant transmissibility. When the test sweeps through a resonant frequency, the transmissibility peaks between the two channels. When WinVCS identifies a resonant frequency, it dwells on that point, adjusting the frequency as necessary keep the sine wave right on the resonance.

This section provides two procedures. The first procedure, *Running the Test*, describes how to run a normal RSD test. It describes how to locate the resonant frequencies using a sweep test, and how to set up and run the RSD test. If you are having trouble locating the resonant frequencies, *Finding the Resonant Frequencies by Touch* describes how to find the areas of resonance on your product for proper accelerometer placement.

4.5.3.1. Running the Test

Follow these steps to set up and run RSD:

1. Place the accelerometers in the following positions:

    a. Place the control (channel 1) accelerometer on a rigid part of the product or fixture.

    b. Place the monitor (channel 2) accelerometer on the product where you expect the resonance to occur.

2. Run a sweep test on your product to determine where each resonance occurs:

    a. You can use the default Sweep test provided with the software. To use the default test, select **Open Existing Test** from the File menu, and select SWEEP.

    b. Select Test Options from the Options menu, and make the following changes:

        i)   In the Test Profiles screen, change the monitor accelerometer to 2.

        ii) In the Sweep Segment Definition screen, set the control values of the sweep to the level that your dwell test will run.

            • If you have to run the sweep at a different level, just remember that the resonant frequency may shift as the level changes. This means that you may have to set the dwell test to search for the resonant frequency through a wider frequency range.

        iii) Select **OK** to load the changes into the WinVCS window.

    c. Run the test.

    d. Use either the Transmissibility or the Monitor Acceleration screen to view the sweep test.

    e. Check to see where each resonance occurs, and use the cursor to locate the frequency where each resonance occurs.

    f. As the sweep is running, watch the monitor channel's acceleration levels:

        i)   By default, the monitor channel's acceleration must be less than four times greater than the control channel's acceleration.

        ii) If a resonant frequency is accelerating too much:

- Select **General Options** from the Graph menu, and select the **Advanced** button.

- Increase the Sine display's Monitor Maximum Q entry just enough for the highest resonance to fall within the acceleration limits. WinVCS uses this factor to adjust the entire acceleration plot down to an acceptable level.

- Select **OK** to exit out of each window, and return to the WinVCS window.

g. Once you have documented the resonant frequencies, stop the test.

3. Follow these steps to run the Resonance Search and Dwell test:

    a. Select **New Test** from the File menu. See Figure 4-18.

    b. Select the following parameters from the Test Profile window:

    c. Test type = Fixed

    d. Search & Dwell = ON

    e. Set the Low and High Frequency Limit entries to the frequency range of your search.

       i) The range should be wide enough to compensate for any shift in the resonant frequency. However, a wide range will cause the search portion of the test to get very long.

       ii) Your objective is to learn to select a range for your product that is as narrow as possible, yet wide enough to compensate for any shift in the resonant frequency.

    f. Select channel 1 as the control channel and channel 2 as the monitor channel.

    g. Set the Fixed Test Limits screen to the normal settings of your test.

    h. Select **OK** to return to the WinVCS window.

    i. Run the test.

       i) The test will sweep up and down through the range provided by the frequency limits until WinVCS locates the resonant frequency.

       ii) Once it finds the frequency, it locks into the resonance and dwells at that frequency. WinVCS also loads the frequency into the Fixed Frequency field of the Test Profile screen.

4. Once you stop the test, you can use the frequency loaded Fixed Frequency field entry to run a Fixed test. Simply turn Search and Dwell off.

Figure 4-18. RSD Parameters

4.5.3.2.   Finding the Resonant Frequencies by Touch

Sometimes, it can be difficult to find a resonant frequency. If you are having difficulty achieving a successful resonance dwell, the accelerometers may not be positioned properly.

Follow these steps to find the proper position for the accelerometers:

WARNING: The shaker's conducting flexures and welding cables carry live currents that can kill you. Make sure that the Shaker's thermal shield and armature insulation are in place to cover the flexures before operating the shaker.

WARNING: Use extreme caution when working with a live product load. Electrical shock can kill you.

CAUTION: Use double ear protection (i.e., earplugs and muffs), and wear safety glasses when working around an operating shaker.

1.   Place the control accelerometer on a rigid part of the product under test or fixture.

2.   Place the monitor accelerometer on the area of the product where you suspect the resonance will occur.

3.   Run a standard sweep test, and watch the Monitor Acceleration screen.

4.   As WinVCS sweeps though the frequencies where resonance is occurring, touch the product at the locations where the most severe vibration is occurring. You should be able to feel where the resonance is the greatest.

5.   Stop the test, and move the monitor accelerometer to the part of the product where you felt the greatest resonance.

6.   Run the sweep and RSD tests described in *Running the Test*.

Section 5
Shock Vibration Mode

5. Overview

The Shock Vibration mode functions allow you to define, edit, run, and view shock vibration tests. This section describes the Shock Vibration mode graphs, and it provides the procedures for defining and editing Shock mode tests.

5.1. The Shock Mode Graphs

The Shock mode graphs display the defined test and the real-time closed loop displays during the test. The defined test plots the desired response plot from the shaker. The real-time closed loop graphs show how the system is operating to achieve the desired response:

- The Acceleration, Velocity, and Displacement graphs plot the actual accelerometer readings from the shaker for the three control mode

- The Drive graph plots the drive signal output to the shaker amplifier.

The following topics describe each type of graph.

5.1.1. Acceleration Profile Graph

The Acceleration Profile graph displays the programmed demand plot, tolerance and abort limits, and the response plot. Refer to Figure 5-1. WinVCS plots the Acceleration profile in Time (ms) versus Amplitude (g). The Acceleration graph includes the Demand plot, the Tolerance Limits, and the Abort Limits.

When a test is running, the response plot appears on the graph. The response plot displayed is the current shock pulse. The response is updated each time a new shock pulse is input from the shaker accelerometer through the I/O module.
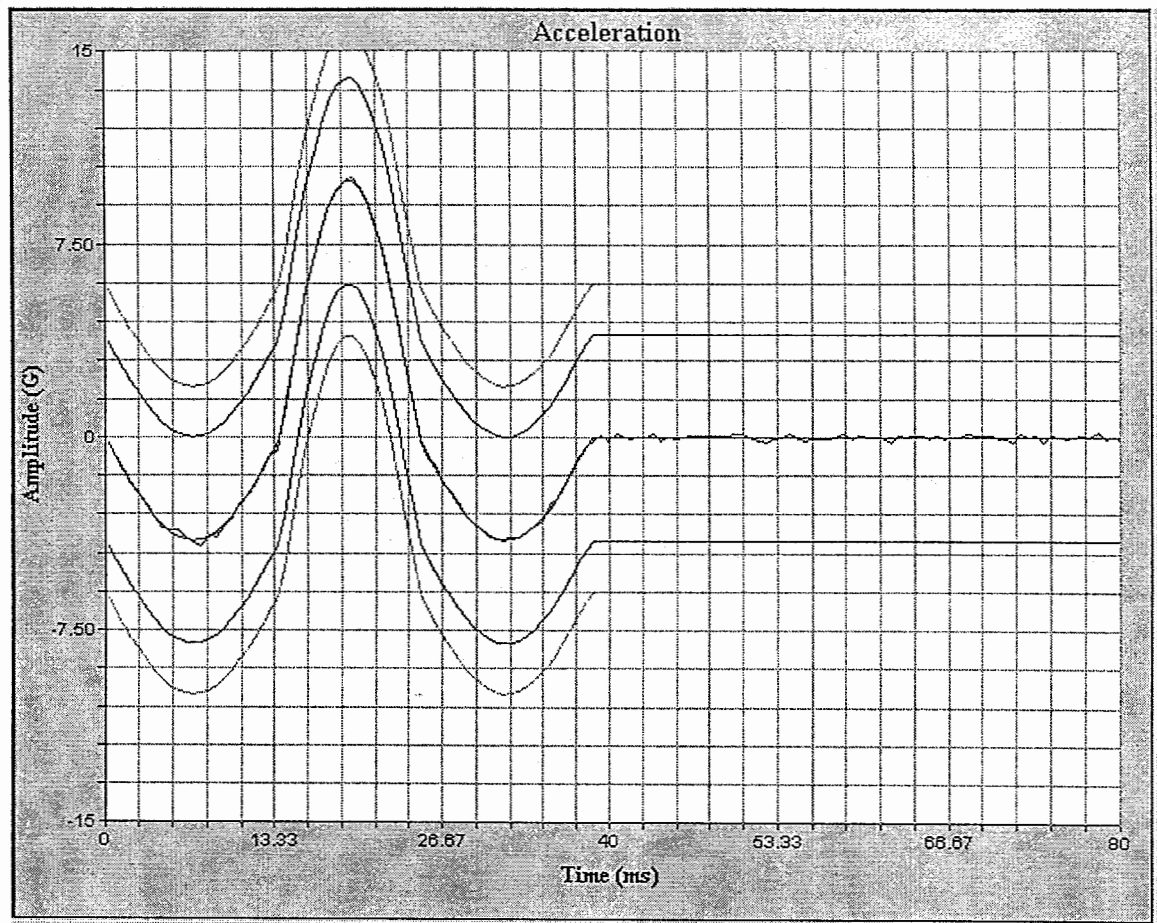
Figure 5-1. Sample Shock Mode Acceleration Graph.

5.1.2. Velocity Graph

The Velocity graph displays the velocity of the shock pulse. WinVCS plots the velocity profile in Time (ms) versus the Amplitude (in/sec) of the shock wave. Refer to Figure 5-2. When a test is running, WinVCS plots the velocity of the shock wave response on the graph for comparison to the profile
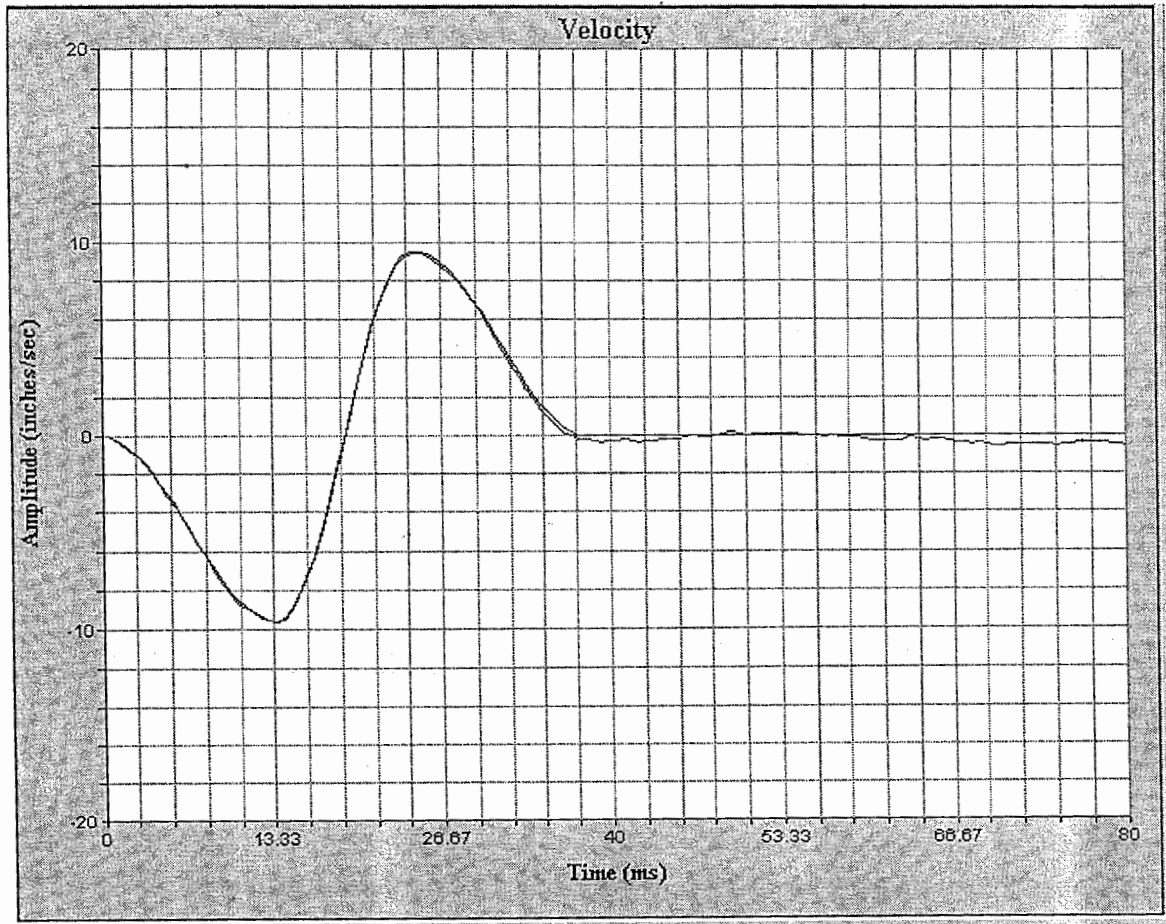
Figure 5-2. Sample Shock Mode Velocity Graph.

5.1.3.   Displacement Graph

The Displacement graph displays the displacement of the shock pulse. WinVCS plots the displacement profile as Time (ms) versus the Displacement (inches) of the shock wave. Refer to Figure 5-3. When a test is running, WinVCS plots the displacement of the shock wave response on the graph for comparison with the profile.
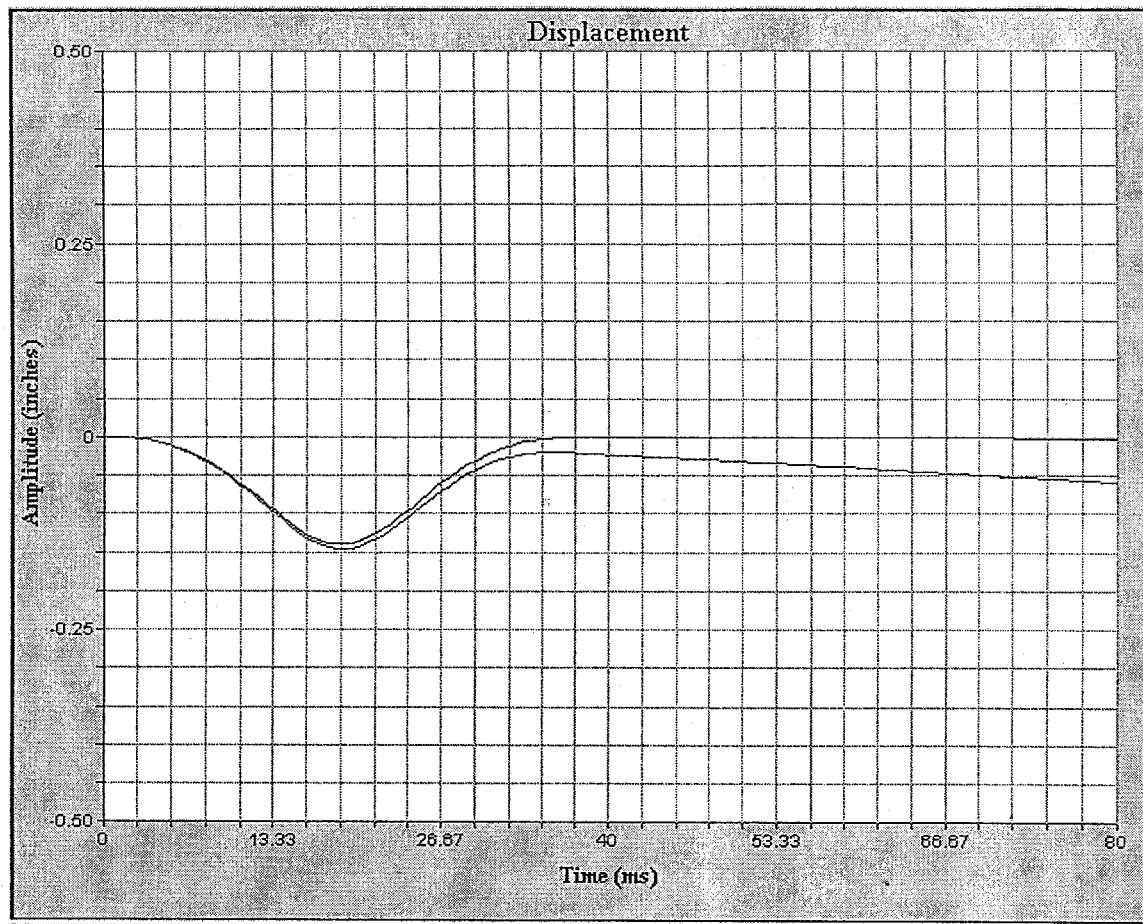
Figure 5-3. Sample Shock Mode Displacement Graph.

5.1.4. Drive Graph

The Drive graph displays the drive applied to the shaker by the VCS. WinVCS plots the drive as Time (ms) versus the amplitude (Volts) of the drive signal. Refer to Figure 5-3.
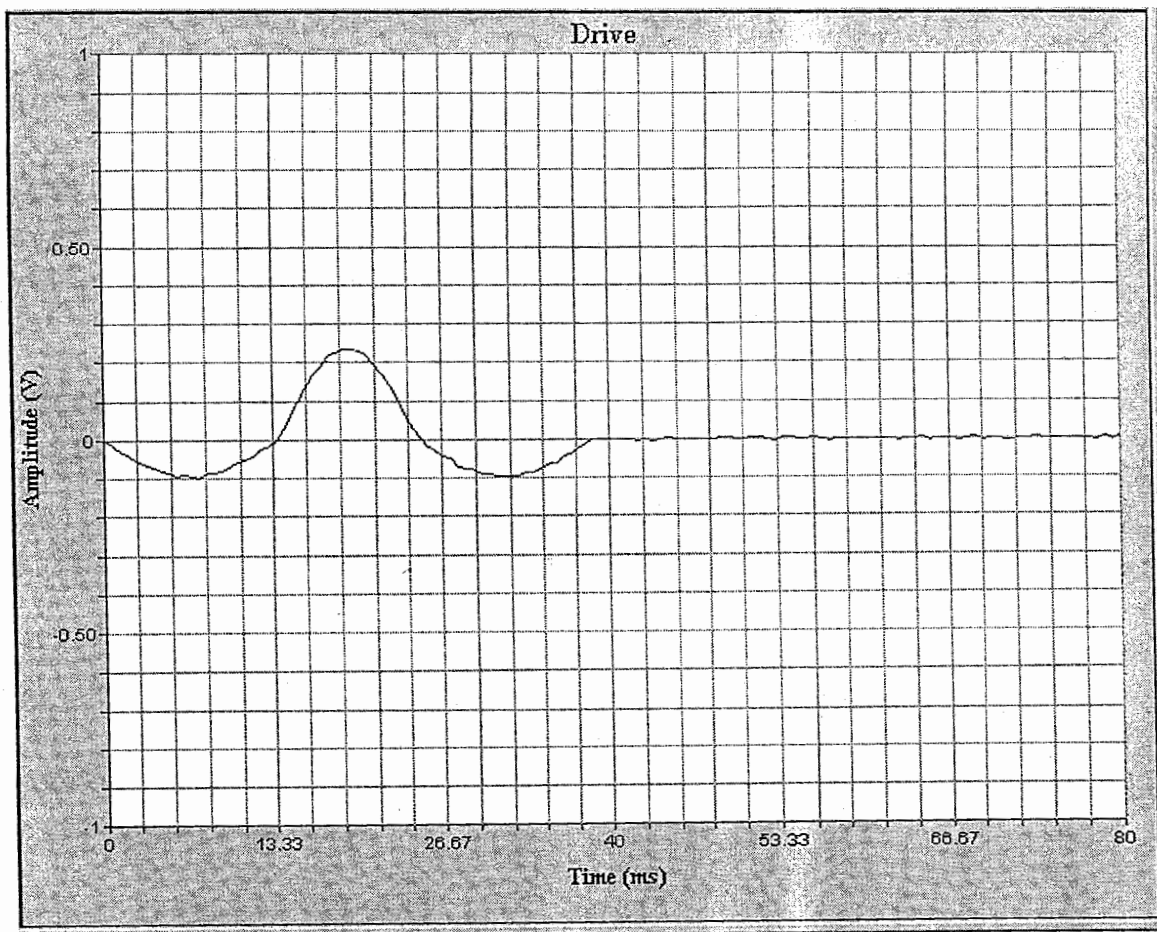
Figure 5-4. Sample Shock Mode Drive Graph.

5.2. Defining a New Shock Mode Test

WinVCS provides a test definition wizard for each vibration mode. The Shock mode wizard is the Shock control System Properties window. This window provides access to the three test displays through tabs. Once you define the test, WinVCS loads the test into the WinVCS main window. You can access the same parameter displays and tables through the Options menu's Test Options command.

NOTE: Use the *Save* or *Save as* File menu commands to save the defined test.

To enable the Shock mode test wizard:

1.   At the WinVCS window, select the **Shock** button (⬛).

2.   Select the **New Test** button (⬛) to open the Shock Control System Properties window. See Figure 5-5.

3.   This window provides access to all the display through folder tabs. Once you finish editing the profile, click on **OK** to accept the canges or on **Cancel** to disable the changes.

4.   Refer to the paragraph 5.2 sub-topics to define a complete test.

Shock Control System Properties

Test Define | Test Limits | Level Schedule

Pulse Peak: 10 G	Pulse Polarity: Positive
Pulse Width: 11 ms	Control Type: Shaker
Waveform Type: Half Sine	Pulse Delay: 4 Sec
Pre/Post-Pulse: 40 %	Control Gain: 5e-005

OK   Cancel   Help
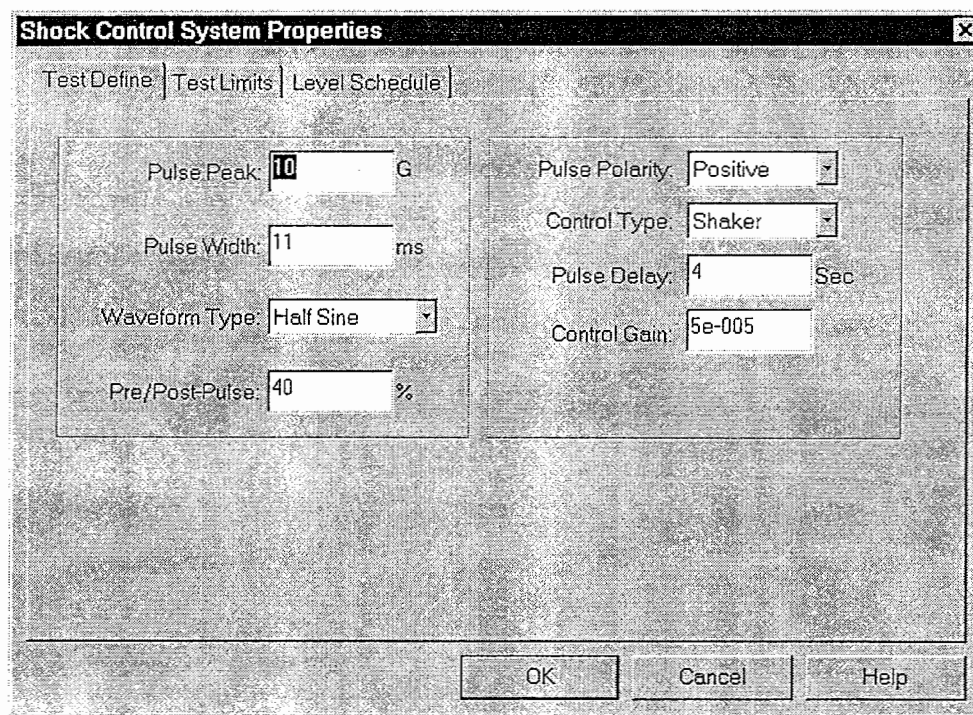
Figure 5-5. Shock Control System Properties Window.

5.2.1. Test Define Displays

The Test Define displays allow you to set up the over-all characteristics of the test. See Figure 5-6. Edit the fields as follows:

Figure 5-6. Test Define Parameter Displays.

Pulse Peak Field   Enter the peak acceleration that the pulse will reach into this field.

Pulse Width   Enter the duration of the pulse in milliseconds.
Field

Waveform Type   Choose the basic shape of the pulse from the pull-down list.
Pull-down List

Pre/Post-Pulse   Enter the percent of peak acceleration for the pre-pulse and post-pulse into this field.
Field   These pulses combine to return the armature to zero acceleration, velocity, and
                           displacement after the shock pulse.

- If you increase the value, the acceleration of both pulses increase and their pulse widths decrease.

- If you decrease the value, the acceleration of both pulses decrease and their pulse widths increase.

Pulse Polarity   Choose the direction of the acceleration pulse from the pull-down list.
Pull-down List

NOTE: If the response pulse moves in the opposite direction of the demand pulse, you need to change the polarity at the I/O module.

- If the drive cable is connected to OUTPUT +, move it to OUTPUT-.

- If the drive cable is connected to OUTPUT -, move it to OUTPUT+.

Control Type   Choose Shaker or Coax control from the list. Shaker control is for normal test
Pull-down List   operations, and Coax control is used during end-around-test operations. You normally
                           select Shaker control.

Pulse Delay   Enter the number of seconds between pulses into this field. Any value below four
Field   seconds defaults to four seconds.

Control Gain   This field allows you to adjust how fast WinVCS equalizes the drive signal to reach the
Field   demand defined by the test.

- A larger gain causes the signal to jump more quickly to the demand level.

- If the gain is too large, the signal gain can jump past the abort limits, causing WinVCS to abort the test.

5.2.2.   Test Limits Displays

These displays define performance limits of the test. See Figure 5-7. The displays are defined as follows:

Figure 5-7. Test Limit Displays.

+Tolerance Field	Enter the tolerance limit above the reference plot in positive units as a percentage of acceleration peak. The response acceleration must stabilize below this limit before the pulse quantity count starts. WinVCS issues a warning any time the acceleration response plot crosses the limit.
-Tolerance Field	Enter the tolerance limit below the reference plot in positive units as a percentage of acceleration peak. The response acceleration must stabilize above this limit before the pulse quantity count starts. WinVCS issues a warning any time the acceleration response plot crosses the limit.
+Abort Field	Enter the abort limit above the reference plot in positive units as a percentage of acceleration peak. Once the test starts, WinVCS aborts the test if the acceleration response plot crosses the limit.
-Abort Field	Enter the abort limit below the reference plot in positive units as a percentage of acceleration peak. Once the test starts, WinVCS aborts the test if the acceleration response plot crosses the limit.
Start Limit Field	Enter the maximum allowable drive signal output (mV) allowed during the start of the test. If the drive signal exceeds this value during start-up, WinVCS aborts the test.
Run Limit Field	Enter the maximum allowable drive signal output (mV) during test operations. WinVCS aborts the test if the drive signal exceeds this value.

5.2.3.   Level Schedule Table

This table allows you to operate the test at different levels in relation to the reference profile. Refer to Figure 5-8. Each level runs for a defined number of shock pulses before moving to the next level. The table's fields are defined below:

Test Define	Test Limits	Level Schedule			
	Level	Pulse Qty	dB Level	% Level	Start
	1	0	0.00	100.00	Normal
	2	0	0.00	100.00	Normal
	3	0	0.00	100.00	Normal
	4	0	0.00	100.00	Normal
	5	0	0.00	100.00	Normal
	6	0	0.00	100.00	Normal
	7	0	0.00	100.00	Normal
	8	0	0.00	100.00	Normal
	9	0	0.00	100.00	Normal
	10	0	0.00	100.00	Normal
	11	0	0.00	100.00	Normal
	12	0	0.00	100.00	Normal
	13	0	0.00	100.00	Normal

Figure 5-8. Level Schedule Table

Level Schedule Table   This table lists all the defined level schedule entries for a test. It allows you to operate the test at different levels in relation to the reference profile.

- Use the arrow keys to navigate the fields.

- Use the **DELETE** key to clear the currently selected row. (select a row by single-clicking any field in the row)

- Use the **DELETE** key to clear the currently selected field (select a field by double-clicking it)

- Copy data to the Windows clipboard by selecting the data (from this or another spreadsheet) and using the copy function. The initial cells must be in the same layout as the destination cells.

- Paste data from the Windows clipboard using the Paste function. Single-click the first field of the destination row before pasting.

Note that the table automatically re-sorts by level number.

Level Field   The level number determines the sequential order of operation.

Pulse Qty Field   Enter how many times the level will repeat the pulse before the test moves to the next level.

dB Level Field   Enter the number of dB's (g) the test will run above or below the full level of the test.

% Level Field   Enter the percent (0-100) of the full test that WinVCS will output. The dB Level field must be set to zero (0) to use this field.

Start Pull-down
List

Choose the Start Mode from the pull-down list:

- **Normal** starts the scheduled test once the full equalization process is completed. WinVCS brings up the drive, equalizing the drive at several points until it reaches full equalization.

- **Model** allows you to save the drive output for the scheduled test. When you run a test, WinVCS looks for a saved drive. If a drive is not available, WinVCS performs a Normal mode start. Once you complete a successful run at that level, press **CTRL + D** to save the drive. Once you save a Model drive, WinVCS will immediately develop the saved drive and equalize from the drive each time it moves to that level.

- **Resume** performs the same function as the Model drive automatically. It saves the drive at the end of a successful run.

Enter Button

Click this button to apply the contents of Edit Current Level Entry fields to the line that is highlighted in the table.

5.3. Editing an Existing Test

Once you define a test, you can modify it as needed to meet the test requirements, or you can create a new test based on the original test. You can perform these modifications in any operating mode (Run, Stop, or Hold). This allows you to edit the test and watch the results of your changes as WinVCS operates the shaker.

Follow these steps to edit an existing test:

1. Make sure the desired test is loaded into the WinVCS window:

   a. The File menu's New Test command loads the new test into the WinVCS window once you finish defining the test.

   b. The File menu's Open Existing Test command loads the desired defined test into the WinVCS window.

2. Select the Test Options command from the Options window. WinVCS opens the Shock Control System Properties window. See Figure 5-9. This window provides access to all the displays used to define a Random mode test.

3. To edit the test parameters:

   a. Select the desired tab to bring its displays to the front.

   b. Edit the parameters as described in Defining a New Test.

   c. Repeat steps a and b to edit another display.

   d. Once you are finished, select OK to close the window and apply the parameters to the WinVCS window. WinVCS will use the parameters, but it will not save them until you use the Save or Save as command.

   e. If you do not wish to load your changes into the WinVCS window, press Cancel to close the window and lose your edits.

4. To save the edits:

    a. Select [💾] to save the test under its original name.

    b. Select **Save as** from the File menu to save the test under a new name.

Figure 5-9. Shock Control System Properties window.

Section 6
WinVCS Technical Displays and Computer Interface Commands

6. Overview

This section provides the operating procedures for the functions that affect the internal operation of WinVCS, and that calibrate WinVCS to the shaker control interface. First, it provides the operating procedures for the General Options command and its advanced control displays. Next, it provides the procedures for the Calibration menu commands. Finally, it describes the GPIB and TCP/IP communication interface.

6.1. Setting General Options Command's Global Parameters

The General Options command provides access to the global commands and the advanced internal settings for the vibration modes. When you select General Options from the Options menu, WinVCS opens the Program Options window. See Figure 6-1. The window's fields and buttons are described below.

Communications Pull-down List
This pull-down list provides two functions:

- At the VCS, select the communications port being used as the command port from the pull-down list. The command port is connected to the I/O module's Master RS-232 Connector port.

- The TCP/IP selection is used for remote computer control. See the IP Address field description for more information.

IP Address Field
Used with the TCP/IP Communication selection for remote computer operation. The TCP/IP function operates as follows:

- The VCS computer and a remote computer are networked on a TCP/IP interface. Two examples of TCP/IP are the Internet or a local Ethernet interface.

- WinVCS is running at the VCS and using the selected command port.

- The remote computer is also running WinVCS.

- On the remote computer, select the TCP/IP selection from the Communications pull-down list, and enter the IP address of the VCS computer into the IP Address field. The IP Address field can contain either a numerical IP address (i.e., 192.9.200.34) or an alphanumeric host name (i.e., winvcs.thermotron.com).

- The remote computer can now run the shaker over the TCP/IP interface.

  NOTE: See topic 6.3 for more information.

DSP RAM Pull-Down List
Select the random-access memory chip that is installed in the WinVCS computer's Digital Signal Processor board.

Figure 6-1. Program Options Window.

GPIB Address Field	Enter the IEEE-488 address of the VCS computer into this field. This field sets up WinVCS for communication over an installed GPIB interface. See topic 6.3 for more information.
Units	Toggle WinVCS between English (US) and Metric units.
Load Last Test On Start Check Box	Mark this box to load the defined test that was last loaded into the WinVCS window the next time you start the program.
Stop VCS if TCP/IP Disconnects Check Box	Mark this box to stop the VCS system if the TCP/IP connection is terminated.
Advanced Button	Click this button to open the WinVCS Advanced Options window. These options adjust the internal settings of the WinVCS program.
Enable Web Server Check Box	Mark this box to enable WebVCS. This enables the built in HTTP server.
Web Server Port	Enter the web server's port location. The default port defined for World Wide Web servers is 80.
Tolerance and Abort Pull Down Lists	Select the color of the limit lines from the pull-down list. These lines appear on all the reference and response graphs.
Cursor Pull-Down List	Select the color of the cursor's vertical line and coordinates from the pull-down list. The cursor's line and coordinates appear on any graph when you click on the graph.
Graphing Refresh Rate (fps) Slider	Drag the slider to select your preferred graphing refresh rate.
TCP/IP Update Delay	Adjusts the interval between TCP/IP updates. The default setting is 2 sec.
OK Button	Closes this dialog and saves any changes you have made.
Cancel Button	Closes this dialog without saving any changes you have made.

6.1.1. Using the General Options Command's Advanced Settings

The advanced settings affect the performance and response of the WinVCS program and the DSP card. To edit the advanced settings:

1. Select General Options from the Options menu to display the Program Options dialog box. See Figure 6-1.

2. Select [Advanced...] to open the Advanced Options window. See Figure 6-2.

    •   This window displays special settings for each vibration mode. They directly affect the performance WinVCS and require special care when editing them.

3. Select the tab for the vibration mode you wish to edit.

4. Enter the desired values into the fields. See Topics 6.1.1.1, 6.1.1.2, and 6.1.1.3 for descriptions of each field.

5. Once you you finish editing the fields:

    •   Press [OK] to accept the settings and close the window.

    •   Press [Cancel] to close the window without accepting the edits.
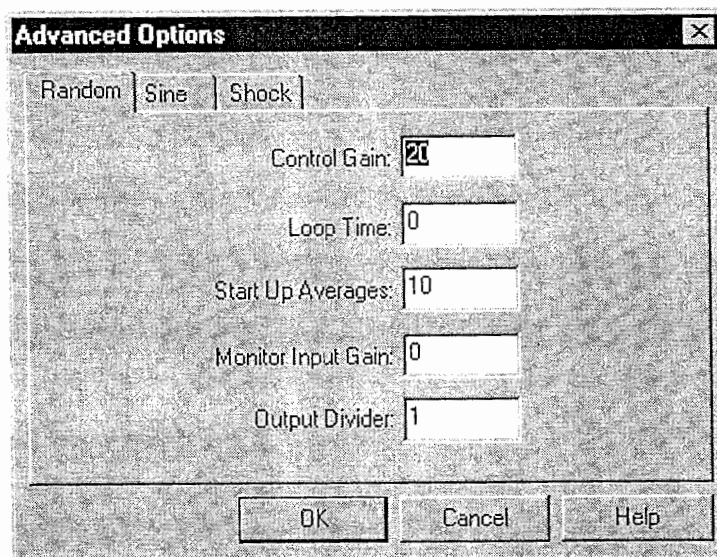
Figure 6-2. Advanced Options – Random Mode.

6.1.1.1.   Random Mode Advanced Settings

The Random mode advanced settings adjust the internal operations of WinVCS during the Random mode. See Figure 6-2. The Random mode fields are described below.

Control Gain Field   Enter a value that determines how fast the control algorithm increases the drive signal's output spectrum. A larger gain brings up the system with larger jumps. The default value is 10.

Loop Time Field   Enter how often the control algorithm is performed during equalization. The fastest rate is every four seconds. Enter a zero to use the default values.

Start Up Averages Field   Enter the desired average factor. This field allows you to enter a lower average factor than the default value of 10. A lower value provides tighter control during the equalization process.

Monitor Input Gain Field   Your field entry affects the AUX output of WinVCS when the AUX output of the I/O module is connected to connector J3. Any entry greater than 0.00 sets the AUX outputs to a fixed gain. The default value is 0.00.

CAUTION: Fixed gains can cause system overloads and are your responsibility!

Output Divider Field   This entry allows you to reduce the drive range of WinVCS to allow greater accuracy. WinVCS can output 10V peak. The divisor is applied directly to the maximum output. (A divisor of 5 produces a maximum output of 2 V peak.) For a maximum output, set the divisor to 1.

NOTE: Remember to leave enough room for a margin of error.

6.1.1.2.   Sine Mode Advanced Settings

The Sine mode advanced settings adjust the internal operations of WinVCS during the Sine mode. See Figure 6-3. The Sine mode fields are described below.
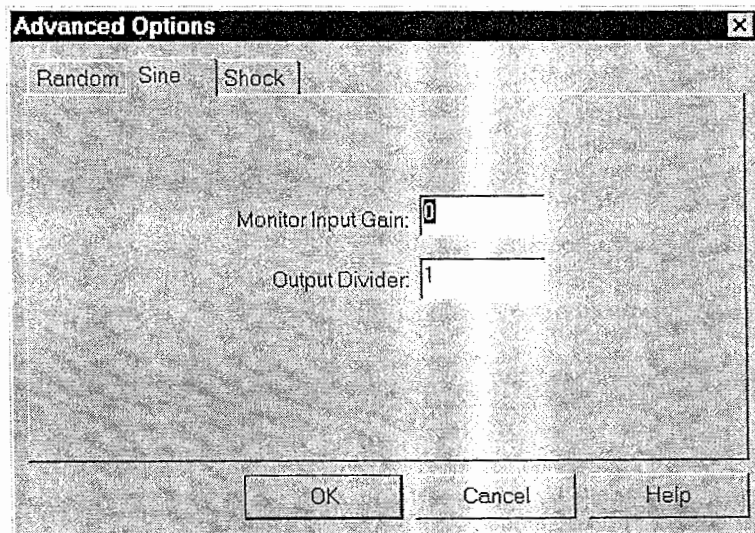
Figure 6-3. Advanced Options – Sine Mode.

Monitor Input Gain Field — Your field entry affects the AUX output of WinVCS when the AUX output of the I/O module is connected to connector J3. Any entry greater than 0.00 sets the AUX outputs to a fixed gain. The default value is 0.00.

> **CAUTION:**   Fixed gains can cause system overloads and are your responsibility!

Output Divider Field — This entry allows you to reduce the drive range of WinVCS to allow greater accuracy. WinVCS can output 10V peak. The divisor is applied directly to the maximum output. (A divisor of 5 produces a maximum output of 2 V peak.) For a maximum output, set the divisor to 1.

> **NOTE:**   Remember to leave enough room for a margin of error.

6.1.1.3.   Shock Mode Advanced Settings

The Shock mode advanced settings adjust the internal operations of WinVCS during the Shock mode. See Figure 6-3. The Shock mode fields are described below.
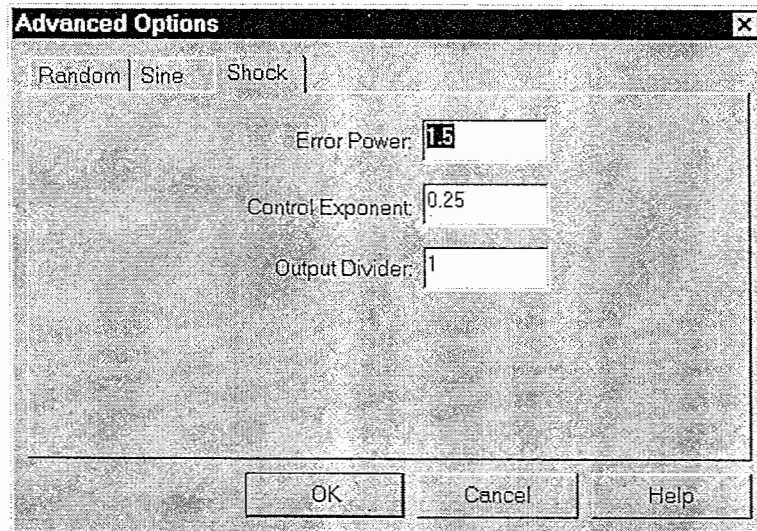
Figure 6-3. Advanced Options Window – Shock Mode.

Error Power and Control Exponent Fields   These fields allow you to adjust the drive output for greater control. This becomes very important during tests with very narrow pulses. To adjust the output, apply the Error Power and Control Exponent values to the following formula:

Output Adjust is Equal to:

$$\text{control gain} \times \text{error}^{\wedge \text{error power}} \times \text{frequency}^{\wedge \text{control exponent/frequency}}$$

Output Divider Field   This entry allows you to reduce the drive range of WinVCS to allow greater accuracy. WinVCS can output 10V peak. The divisor is applied directly to the maximum output. (A divisor of 5 produces a maximum output of 2 V peak.) For a maximum output, set the divisor to 1.

NOTE: Remember to leave enough room for a margin of error.

6.2. Using the Calibration Menu Commands
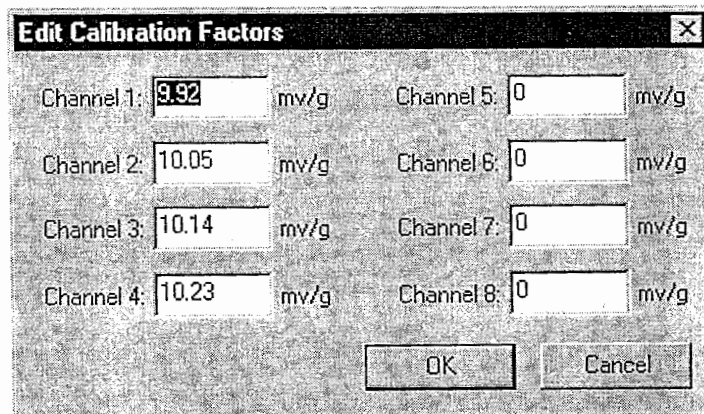
The Calibration menu allows you to enter accelerometer sensitivity ratings, verify the accuracy of the system, and perform preventive maintenance (PM) checks on the VCS hardware and the shaker. The following paragraphs provide the procedures for operating the calibration commands.

6.2.1. Edit Factors

The Edit Factors command allows you to enter and store the factory certified sensitivity for the accelerometer connected to each input channel.

*   If a channel has a directly connected ICP accelerometer, always enter and save the factory certified value for the accelerometer's sensitivity.

*   If a certified accelerometer is amplified and then applied to the input channel, always enter and save the factory certified value for the accelerometer's sensitivity multiplied by the amplification. Use the exact amplification factor applied by the external ICP power supply or charge amplifier.

When you select Edit Factors from the Command menu, WinVCS displays the Edit Calibration Factors dialog. See Figure 6-4. WinVCS uses these factors in all of its response calculations. Enter the sensitivity of each accelerometer into its channel field. Once you are finished editing the fields, select **OK** to load the new values into WinVCS and close the dialog. The **Cancel** button closes the dialog without saving the edits.

Figure 6-4. Edit Calibration Factors Dialog.

6.2.2. Live Calibration

Live Calibration uses an internal single-frequency sine generator output to drive the shaker. Live Calibration reads and displays the accelerometer response to the drive signal, one channel at a time. Use the sine generator drive and accelerometer response data to perform the following functions:

- Verify operation of WinVCS and the VCS hardware

- Verify the sensitivity of accelerometers with unknown sensitivity levels

- Check the performance of the shaker

- Other shaker PMS checks

NOTE: Live Calibration provides readings that are close to the accelerometer's sensitivity. However, they are not as accurate as a certified calibration reading from a calibration laboratory.

When you select Live Calibration from the Calibration menu, WinVCS opens the Live Calibration window. See Figure 6-5. The fields and buttons are described on page 6-8. They are followed by a general procedure describing how to use the Live Calibration window.
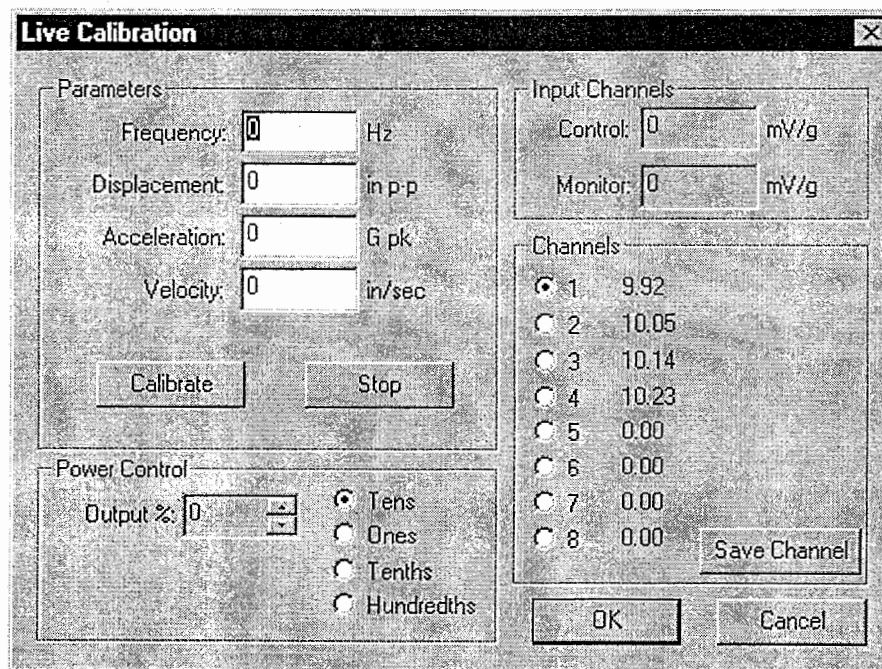
Figure 6-5. Live Calibration Window.

6.2.2.1.   Using the Live Calibration Fields and Controls

The following procedure describes how to use the Live Calibration window's fields and controls.

1. The Parameters group fields define the performance factors for the sine wave and shaker response. Enter values into any two of the four Parameters group fields. WinVCS automatically calculates the other two fields.

   Frequency Field   Enter the desired frequency for the internal sine generator. Enter any value between 5Hz and 3KHz that is within the limits of your shaker.

   Displacement Field   Enter the desired peak-to-peak displacement of the armature. Enter any value between 0 and 2 inches (0 and 50.8 mm) that is within the specified limits of your shaker.

   Acceleration Field   Enter the desired acceleration factor of the shaker.

   Velocity Field   Enter the desired velocity of the armature that is within the specifications of your shaker.

2. Once you edit any two of the Parameters Group fields, click the **Calibrate** button to enable the calibration process:

   • WinVCS calculates the internal Parameters group parameters.

   • As you follow the Live Calibration procedure, WinVCS uses the Parameters group to calculate the sensitivity of each selected input channel.

3. Operate the Power Control group controls to set and adjust the power output of the drive signal:

   Output % field and spin button   Enter the desired percentage of full output into this field. When you click the spin button, the output level increases or decreases as defined by the selected radio button.

   Radio Buttons   Select the button that provides the desired gain for the spin button. For example, select the **Tenths** radio button to increase or decrease the Output % field's value by 0.1% with each click of the spin button

4. Select the accelerometer input channel that you wish to test from the Input Channels group's radio buttons.

5. As you adjust the power for the selected channel, watch the Input Channels display fields.

   • The Control and Monitor fields display the calculated sensitivity of the input channel through the Control and Monitor A/D converters at the I/O module.

   • These readings are close to the accelerometer's sensitivity. However, they are not as accurate as a certified calibration reading from a calibration laboratory.

6. If you wish to place the displayed channel's reading in temporary storage, click on the **Save Channel** button. WinVCS displays the saved reading next to the channel's radio button.

7. Perform steps 3 through 6 to check the sensitivity for all the desired accelerometer input channels.

8. Click the **Stop** button at any time to stop the current calibration process. You will need to start at step 1 to perform more calibration operations.

9. To exit from Live Calibration without changing the values in the Edit Factors dialog box, click on **Cancel**.

10. To save the values from temporary storage to the Edit Factors dialog box, click **OK**. WinVCS will now use these values to calculate the response from the shaker.

6.2.3. Input Verification

Input Verification allows you to verify the internal accuracy of the I/O module's input channels. When you select Input Verification from the Calibration menu, WinVCS opens the Input Verification dialog box. See Figure 6-6.
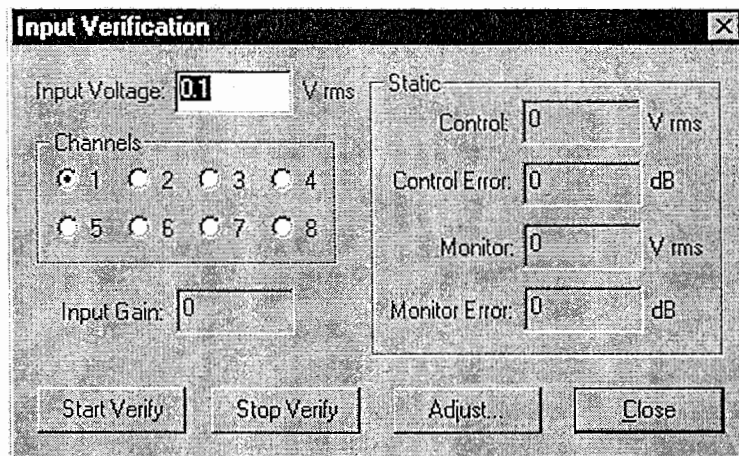
Figure 6-6. Input Verification Dialog Box.

The following procedure describes how to use the Input Verification command to perform the test. For the test, you need a sine oscillator capable of developing a 50-to-150mVrms signal between 5Hz and 4500Hz.

NOTE: The **Adjust** button is restricted to use under direction from a Thermotron shaker engineer or tester. When you click this button, the "Enter Code" dialog opens to restrict access to the function.

1.   Write down the Gain and ICP switch settings for all the active input channels on the I/O module rear channel. See Figure 6-7.

2.   Set all the active channels' Gain switches to 1 and set their ICP switches to ON.

3.   Connect the sine oscillator to the Channel 1 input on the I/O module's rear panel. See Figure 6-7.

4.   Turn the Channel 1 ICP switch to OFF. All the other channels' ICP switches should be ON.

5.   Set the sine oscillator to between 50 and 150mVrms, and to between 500 and 1500 Hz.
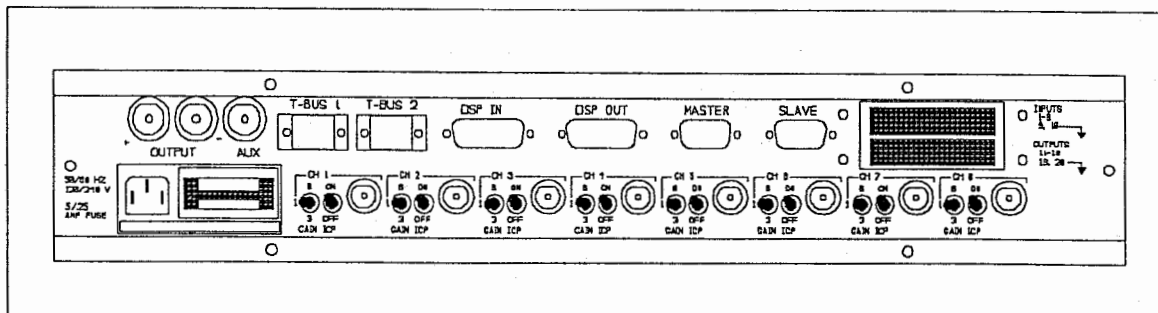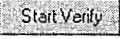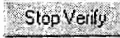
Figure 6-7. I/O Module Rear Panel.

6. Enter the exact voltage reading from the sine oscillator into the Input Voltage field on the Input Verification dialog.

7. Click [Start Verify] to start the test.

8. Click on the Channels group radio button for the channel you are testing. The Input Verification window displays the following values:

Input Gain Field	Displays the gain WinVCS is applying to the input signal as it reads the signal.
Control Field	Displays the actual input voltage being read by WinVCS through the control A/D converter.
Control Error Field	Displays the difference between the Input Voltage Field entry and the voltage reading by WinVCS as displayed in the Control Vrms field.
Monitor Field	Displays the actual input voltage being read by WinVCS through the monitor A/D converter.
Monitor Error Field	Displays the difference between the Input Voltage Field entry and the voltage reading by WinVCS as displayed in the Monitor Vrms field.

9. Sweep the sine oscillator from 5Hz to 4500Hz. Make sure the control and monitor error fields stay within ±0.5dB during the entire sweep. (If your I/O module only has the control A/D, only check the control values.)

10. Click [Stop Verify] to stop the test, and turn off the sine oscillator.

11. Set the current channel's ICP switch to ON.

12. Move the sine oscillator connection to the next channel, and turn the channels ICP switch to OFF.

13. Repeat steps 5 through 12 for each channel.

14. Repeat steps 5 through 12 for each channel again, but set the oscillator's voltage to 1.0 Vrms for each test.

15. Click [Stop Verify] to stop the test, and turn off the sine oscillator.

16. Disconnect the sine oscillator from the I/O module.

17. Return the ICP and Gain switches to their original settings.

6.3. Using the TCP/IP or GPIB Computer Interface

The WinVCS computer interface functions allows you to operate WinVCS from a remote computer using the following interface Selections:

- The TCP/IP interface allows you to communicate over any TCP/IP network, including the Internet, an Ethernet interface, or other TCP/IP applications. Use your preferred TCP/IP network to use this interface.

- The GPIB interface allows you to communicate over an IEEE-488 interface. Use a National Instruments AT-GPIB/TNT card to operate over the IEEE-488 interface.

The following topics describe both interface options.

6.3.1. Setting Up and Using the TCP/IP Interface

The TCP/IP interface allows you to operate the VCS computer over any standard TCP/IP network, like the Internet or a local Ethernet network. In addition to using the command set, you can operate the VCS computer from a remote computer that is also running the WinVCS program. The remote WinVCS program operates the interface invisibly and displays the data from the VCS computer on the displays in the WinVCS computer.

The TCP/IP interface is a part of the Windows program on your computer. In order to use it, you must already be networked with the remote computer via a local network or Internet. With the network installed, both computers must be set up in windows for TCP/IP. To install TCP/IP at each computer, follow these steps:

CAUTION: *DO NOT* perform this procedure if your company has a Network Administrator. Contact the Network Administrator for assistance.

1. Open the Windows Control Panel. (Select **Start**, **Settings**, and then **Control Panel.**)

2. Double-click on the **Network** icon to display the Network window. See Figure 6-8.

3. Click on the **Add** button.

4. Double-click on **Protocol** to display the Network Protocol selection.

5. Select Microsoft as the manufacturer, TCP/IP as the network protocol, and click on the **OK** button.

6. Windows will ask for the CD or disk from your Windows platform. Follow the prompts until you return to the Network window with TCP/IP displayed.

7. Click on the TCP/IP line, and then click on the Properties button. The TCP/IP Properties window opens. See Figure 6-9.
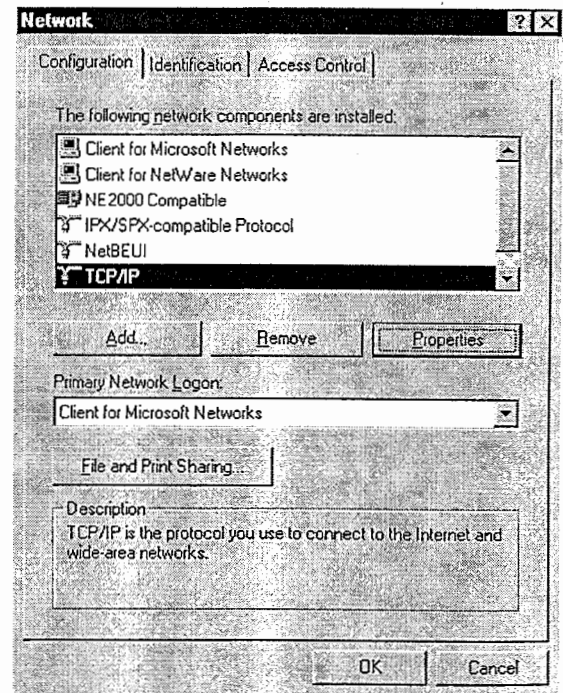
Figure 6-8. Network Window.

8. Click on the **Specify an IP address** button.

9. Enter a number into the IP address field that is similar to the number displayed in Figure 6-9. A period moves you to the next field.

   a. This number must be different on each computer. For example, the VCS computer could be 192.9.201.50 and the remote computer could be 192.9.201.51.

10. Enter 255.255.255.0 into the Subnet Mask field.

11. Click the **OK** button.

12. Follow the prompts until you are prompted to reboot your computer.

13. Click the **YES** button to reboot the computer.

14. Wait for the system to reboot.

15. Test the interface locally on the computers:

   a. Run WinVCS on the VCS computer.

   b. At the VCS computer, select Run from the Windows Start menu (Start).

Figure 6-9. TCP/IP Properties Window.

   c. Enter "telnet localhost 10500" and press **OK**. The Telnet window opens, allowing you to operate WinVCS using the commands listed in Table 6-1.

   d. Exit from telnet.

   e. At the remote computer, select Run from the Windows Start menu (Start).

   f. Enter "telnet *hostname* 10500" and press **OK**. (Replace *hostname* with the VCS computer's IP address number.) The Telnet window opens, allowing you to operate WinVCS from the remote computer using the commands listed in Table 6-1.

16. Once the system is tested, you can operate the VCS computer using the telnet interface, a program, or by loading WinVCS into your remote computer.

   a. To use Telnet, follow these steps:

      i) At the remote computer, select Run from the Windows Start menu (Start).

      ii) Enter "telnet *hostname* 10500" and press **OK**. (Replace *hostname* with the VCS computer's IP address number.) The Telnet window opens, allowing you to operate WinVCS from the remote computer using the commands listed in Table 6-1. See topic 6.3.4 to use the interface commands.

   b. See topic 6.3.2 to use the WinVCS program in the remote computer.

   c. See topic 6.3.4 to use the interface commands.

6.3.2. Using WinVCS Software to Program and Operate from the Remote Computer

The WinVCS program contains the most powerful command set that goes well beyond the commands in Table 6-1. These commands are very long strings that allow you to perform all the WinVCS functions from the remote computer. Follow these steps to use the WinVCS software in the remote computer:

1. Install the TCP/IP interface as described above.

2. Install the WinVCS software into the remote computer as described in Section 7.

3. Run WinVCS on the remote computer and the WinVCS computer.

4. Select the General Options command to open the Program Options window. See Figure 6-10.

5. Select TCP/IP from the Communications pull-down list.

6. Enter the IP address of the VCS computer into the IP address field. (You can also use the computer's network name.)

7. Select **OK**.

Figure 6-10. Program Options Window.

You can now perform all the WinVCS functions from the remote computer. WinVCS allows you to develop programs from the remote computer and download them to the VCS computer to run them. As the VCS computer operates, it sends data back to the remote computer to update the real-time displays and graphs. This interface saves time, because the remote computer uses its own displays combined with the new data sent from he VCS computer.

6.3.3. Setting Up the GPIB Interface

Thermotron uses a National Instruments AT-GPIB/TNT card to interface with the IEEE-488 interface. If you purchased WinVCS with the GPIB option, the interface is set up. If you purchase the card yourself, follow the manufacturer's instructions to install the card into the VCS computer and into the Windows system. Once you install the GPIB interface, follow these steps to set up the properties and GPIB address:

1. Select the **System** icon from the Windows Control panel to open the Properties window.

2. Select the **Device Manager** tab, and click on the AT-GPIB/TNT device.

3. Select the **Properties** button to display the AT-GPIB/TNT Properties window. See Figure 6-11.

4. Set the NI-488 2M Settings as shown in Figure 6-11.

5. Press the **OK** button.

6. Reboot the system.

7. Run WinVCS.

8. Select the General Options command from the Options menu to open the Program Options window. See Figure 6-12.

9. Enter the unique GPIB address of the VCS computer into the GPIB Address field.

10. Select the **OK** button.

11. See topic 6.3.4 to use the command set to operate WinVCS over the GPIB interface.
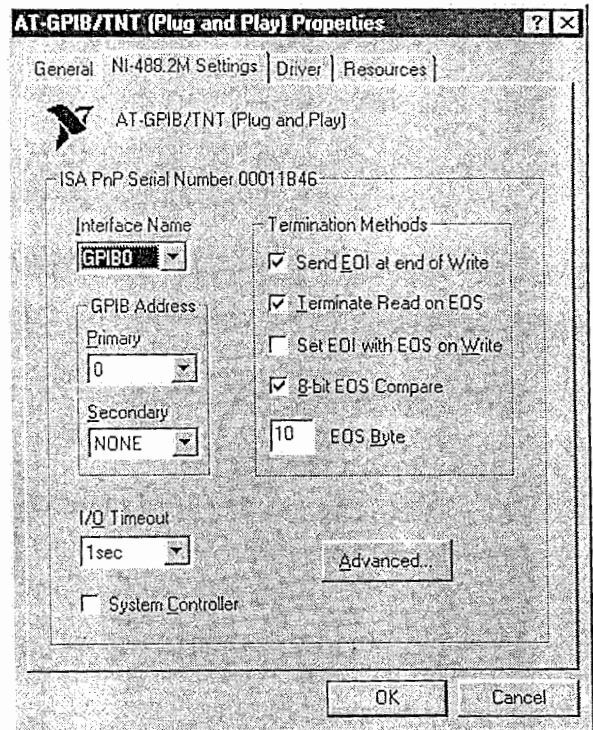
Figure 6-11. AT-GPIB/TNT Properties Window.
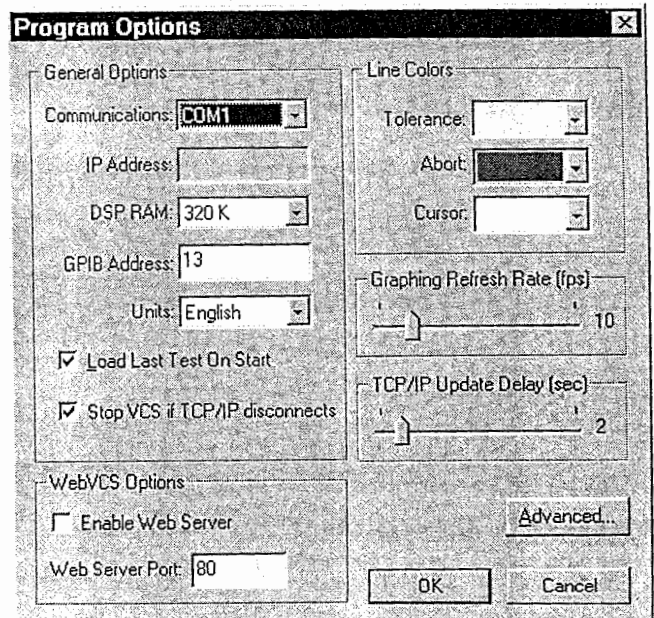
Figure 6-12. Program Options Window.

6.3.4. Using the Command Set

Once you install the GPIB, TCP/IP, or both interfaces, you can operate the VCS computer using the command set listed in Table 6-1. The main difference between the GPIB and TCP/IP is the acknowledgement protocol:

- TCP/IP sends an "OK" back for any command that does not have an associated return response.

- GPIB sends nothing back for any command that does not have an associated return response.

The commands are formatted as operational and query commands:

- An Operational command tells WinVCS to perform a specific operation. It consists of an ASCII command with no question mark. The LOAD filename command also has character string following the command to specify the test to be loaded into the WinVCS window.

- A Query command asks for information from WinVCS. It consists of an ASCII command that always ends with a question mark.

All the commands that worked in VCS DOS will also work with WinVCS. Any DOS command that has no meaning in WinVCS (such as "GOTOVCS") is ignored by WinVCS.

The data can be in character-string, fixed integer, scientific, or command –specific notation:

- Character-string format sends back alphanumeric characters, such as a program filename and path.

- Fixed integer format sends back a pre-defined number of integers. For example, a response denoted as *nnnnn* will send back 00500 for a value of 500.

- Scientific notation uses a 14-character format as follows: $\pm x.nnnnnnne\pm eee$ where x is the whole number portion, n is the decimal portion, and e is the exponent. The sign (+ or -) and is always present for the number and its exponent. For example, +1.994561e+001 equals the number 19.94561.

- Command-specific notation is explained in each command's description.

Table 6-1. Computer Interface Command Listing. Page 1 of 4.	
Command	**Description**
General Program Commands	
TIMEODAY? Or TIME?	Gets the current time of the day. Format: *hh:mm:ss* (hh = hours; mm = minutes; ss = seconds)
FILENAME?	Returns the full pathname of the currently loaded file. "Untitled" if there is none.
PACKAGE?	Returns the currently loaded mode. Can be RANDOM, SINE, or SHOCK.
GOTORANDOM	Switches to random mode (not necessary, here for backwards compatibility).
GOTOSHOCK	Switches to shock mode (not necessary, here for backwards compatibility).
GOTOSINE	Switches to sine mode (not necessary, here for backwards compatibility).
GOTOVCS	Does nothing (here for backwards compatibility).
RUN	Runs the currently loaded test.

Table 6-1. Computer Interface Command Listing. Page 2 of 4	
Command	**Description**
General Program Commands	
STOP	Stops the currently loaded test.
HOLD	Holds the currently running test.
RESUME	Resumes a held test.
LOAD *testname*	Loads *testname* into the WinVCS window. Testname is a valid WinVCS test file accessed by the remote WinVCS computer. The remote WinVCS opens an existing test and sends the test to the VCS computer's WinVCS window to open the test there. The test file must include the .vcs extension. If the test is not in the current directory, a path must be supplied. Example: load c:\winvcs\random\navmat3.vcs
STOREDATA	Stores the current data as a stored data file (the recorded data file name with a sequential extension, starting with 001).
STATENUMBER?	Returns current program state number: 01 – Stopped 02 - Ramping up to level 03 - At level and running

LASTCODE?	Returns current program state code.
	
	    ABORTED – General Abort Condition
	    CONTROLABORT – Aborted due to control limits
	    EMPTYTEST – Test was not completely defined
	    ENDOFTEST – Test ended normally
	    HOLDING – Test is holding
	    MONITORABORT – Aborted due to monitor limits
	    OPENLOOPABORT – Detected an open loop
	    OPERATORSTOP –Operator stopped controller
	    OUTPUTABORT – Drive output limits reached
	    REMOTESTOP – Test stopped remotely
	    RUNNING – Test is running at level
	    STARTING – Test is ramping up to level
	    STOPPED – General stopped condition

TIMELEFT?	Returns the time remaining in the current test. Format: *hh:mm:ss* (hh = hours; mm = minutes; ss = seconds)
LEVEL?	Returns the test's current level number. Format: *nn*

Table 6-1. Computer Interface Command Listing. Page 3 of 4	
Command	Description
Random Mode Commands	
DEMANDRMS?	Returns the G or m/s^2 RMS value for the current level's demand plot in scientific notation.
CONTROLRMS?	Returns the control channel's G or m/s^2 RMS level in scientific notation.
MONITORRMS?	Returns the monitor channel's G or m/s^2 RMS level in scientific notation.
DRIVERMS?	Returns the current output in Volts RMS in scientific notation.
BANDWIDTH?	Returns the current maximum frequency in hertz. Format: *nnnnn*
NUMLINES?	The number of lines in the current test. Can be 100, 200, 400, or 800.
Sine Mode Commands	
DEMANDGPK?	The current reference acceleration peak (G's), returned in scientific notation.
FREQUENCY?	Returns the current frequency of a swept test in scientific notation.
OUTPUTVOLTAGE?	Returns the voltage being output at the current frequency in scientific notation.
CONTROLGPK?	Returns the control response acceleration peak (G's) at the current frequency in scientific notation.
MONITORGPK?	Returns the monitor response acceleration peak (G's) at the current frequency in scientific notation.
CONTROLVPK?	Returns the control response velocity peak at the current frequency in scientific notation.
MONITORVPK?	Returns the monitor response velocity peak at the current frequency in scientific notation.
CONTROLDPK?	Returns the control response displacement at the current frequency in scientific notation.
MONITORDPK?	Returns the monitor response displacement at the current frequency in scientific notation.
CYCLECOUNT?	Returns how many cycles have been completed so far. Format: *nnn*
CONTROLTYPE?	Returns the current control type (acceleration, displacement, or velocity) for the current frequency. 0 – Acceleration 1 – Velocity 2 – Displacement

Table 6-1. Computer Interface Command Listing. Page 4 of 4.	
Command	Description
Shock Mode Commands	
DEMANDGPK?	Returns the defined acceleration peak (G's) for this level in scientific notation.
CONTROLGPK?	Returns the current control response acceleration peak (G's) in scientific notation.
OUTPUTVOLTAGE?	Returns the current peak output in volts in scientific notation.
DEMANDMS?	Returns the width of the pulse in ms in scientific notation.
PULSECOUNT?	Returns the number of successfully run pulses for the current level. Format: *nnnnn*
PREPOST?	Returns the pre and post pulse percentage in scientific notation.

6.4. Viewing the System Status

The System Status window displays the monitor and control input s' status. Refer to figure 6-13.
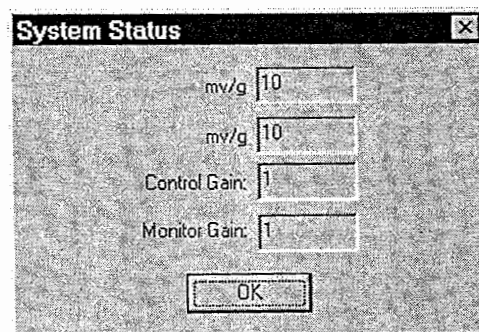
Figure 6-13. System Status Window.

Follow these steps to view the System Status Window:

1. Open the System status window by selecting the System Status option from the Options menu. The following information is displayed:

   Control Acceleration: The mV representation of the control inputs acceleration setting.

   Monitor Acceleration: The mV representation of the monitor inputs' acceleration setting.

   Control Gain: An internal multiplication factor that calculates the proper resolution based on the amplitude setting of the current test.

   Monitor Gain: An internal multiplication factor that calculates the proper resolution based on the amplitude setting of the current test.

2. Select [OK] to return to the WinVCS Window.

6.5. Using the WinVCS Web Server

The WinVCS program features a built-in basic HTTP server that is capable of handling requests for HTML documents. The WinVCS web server is not intended as a replacement for a general-purpose web server, and its functions are limited as follows:

- The size of files served is limited to 512K.

- The only supported MIME types are HTML/text, image/jpeg, and image/gif. Any file with an extension that is not .GIF, .JPEG, or .JPG is treated as an HTML file.

- No security features (i.e. username, password, or IP banning) are present. If any control functionality is implemented (i.e. start/stop, loading tests, etc.) Thermotron recommends that WinVCS remain limited to small local area networks.

- CGI scripting and server side image maps are not supported.

- Downloading Java applets is not supported.

- The WinVCS web server (WebVCS) has a limited capacity and cannot handle a large number of simultaneous connections. Scalability of the system depends on the operating system, and system resources.

- WebVCS implements a small subset of the HTTP 1.0 specification. Time stamps on files are ignored, and GET is the only request that can be made. The only error codes returned are 200 (success) and 404 (file not found).

All the web pages WinVCS uses reside in the C:\Program Files\WinVCS\web directory by default. The default start page is Index.HTML. An example setup is also located in the C:\Program Files\WinVCS\web directory. These files contain examples of WebVCS tags to be used as a guide.

Follow these instructions to enable WebVCS:

1. Select General Options from the Options menu to display the Program Options dialog box. See figure 6-12.

2. Mark the Enable Web Server check box.

3. Enter the Web Server port number. The default port is 80, which is the default port defined for World Wide Web Servers. The port number will become part of the URL (for example, Http://winvcs.thermorton.com:5000 uses a port number of 5000)

4. Select the [OK] button to return to the WinVCS window.

6.5.1. HTML Extensions

WebVCS includes a special "server side tag" which tells it to interact with the WinVCS system to get status information and to control operation. This tag is in the following form:

```
<WINVCS>command</WINVCS>
```

where *command* is any of the supported computer interface commands listed in table 6-1. This tag may appear anywhere in the HTML code that is present on the server, and **must be uppercase** (although the program will return the command in lowercase letters). For example, to load the profile NavMat.vcs, the HTML would be as follows:

```
<WINVCS>load NavMat.vcs</WINVCS>
```

When the server processes the web page, it replaces the entire tag with the output returned from the system. For example, if the following piece of HTML is in a file on the server:

```
Control Response: <WINVCS>controlrms?</WINVCS> G RMS<BR>
Monitor Response: <WINVCS>monitorrms?</WINVCS> G RMS<BR>
Drive: <WINVCS>driverms?</WINVCS> V RMS<BR>
```

It returns the following HTML over the network (the white space in the code is intentional):

```
Control Response: +3.014059e+000          G RMS<br>
Monitor Response: +3.182043e+000          G RMS<br>
Drive: +3.052916e-002       V RMS
```

This is displayed as follows in the web browser:

Control Response: +3.014059e+000 G RMS
Monitor Response: +3.182043e+000 G RMS
Drive: +3.052916e-002 V RMS

Section 7
VCS Electronic Interface

7. Overview

This manual describes the hardware and software systems of the **Vibration Control System** used to program and control **Electrodynamic Vibration Testing Systems** (EVTS), referred to as Shakers

The VCS is a microcomputer based system used to control, monitor, and acquire data from a Shaker. The VCS integrates Random, Shock, and Sine vibration control. The VCS consists of the I/O module, a standard IBM PC-AT compatible computer, and the WinVCS software package.

The VCS provides the following functions and features:

- Provides programmability and profile display through Windows 95 style software screens.

- Applies a programmed drive signal to a Shaker to execute vibration tests on a product.

- Inputs multiple piezoelectric accelerometer signals to interpret the response of the Shaker (or product).

- Corrects the drive signal to compensate for changes caused by the mechanical characteristics of the Shaker (or product).

- Produces a response from the product that conforms (within predetermined limits) to the content of the Standard.

- Produces outputs that permit annotated recording of Response Profiles.

The VCS program, operating system, and system diagnostic programs are entered into the computer memory from the system hard disk. During programming, you enter the parameters for a specific test using the computer keyboard. The computer constructs a Demand Profile from your programmed input. Then you store the Demand Profile to the hard disk under a selected test name.

As a test starts, the computer converts the Demand Profile parameters into an output file called a Drive Profile. The Drive Profile is a data file that stores the actual values of the signal being sent to the Shaker amplifier. The computer's DSP card converts the data file into an output. The DSP card sends the converted data through the DSP OUT port to the I/O module's DSP IN port. Refer to Figure 7-1. The I/O module routes the data through its Digital-to-Analog Converter (DAC) to generate the Drive Profile signal through its OUTPUT port. The shaker amplifier conditions the signal and applies it to the Shaker.

The Shaker's accelerometers send the I/O Module piezoelectric signal responses of the Shaker and product. The signals are input through the BNC Input Channel connectors. The I/O module converts the signals to digital values and sends the data through its DSP OUT port to the DSP card's DSP IN port at the computer.

The VCS computer converts the time-based accelerometer data into a frequency-based Response Profile. The computer compares the Response Profile to the Demand Profile and uses the difference between the two profiles to apply an error correction to the Drive. This correction of the Drive Profile is called equalization.
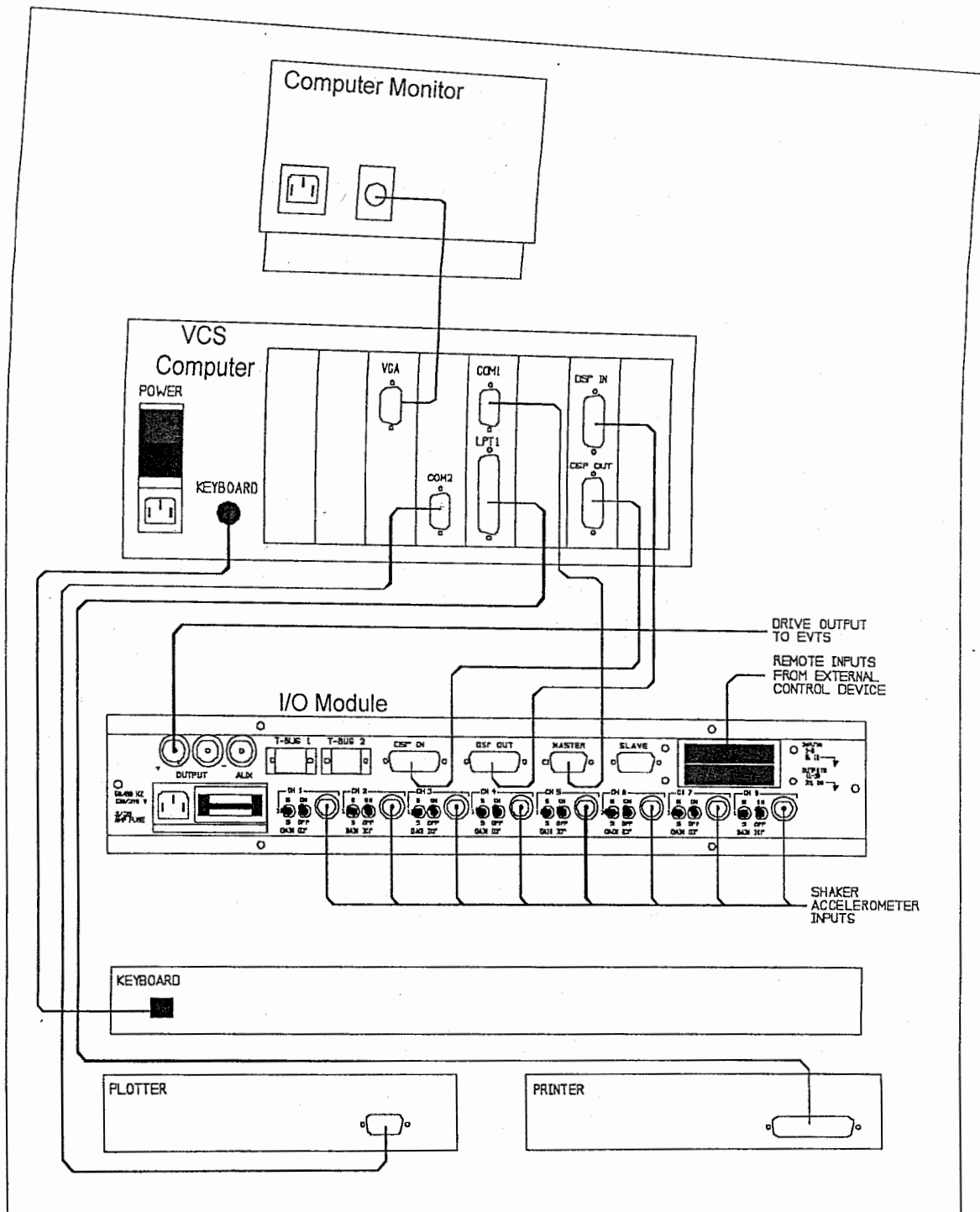
Figure 7-1. VCS Hardware and Interface.

The VCS repeats the equalization process at successively higher output drive signal levels until the drive reaches your specified full test level. When it achieves the full test level, the system begins timing the first test. Since the characteristics of the mechanical system may differ, equalization is continuously active. Ideally, the Response Profile is identical to the Demand Profile. However, mechanical characteristics of the Shaker and product under test can alter some spectral components of the Response Profile. Therefore, it is necessary to compare the Response Profile to the Demand Profile to calculate a corrected Drive Profile. The new Drive Profile is used to generate a new output. The new data is routed through the DSP card to the I/O module's DAC to generate the next drive signal.

7.1. Hardware Description

The VCS hardware consists of the I/O module and VCS computer. Refer to Figure 7-1. A printer and a plotter are optional.

7.1.1. VCS Computer

The VCS computer is the data acquisition and programming unit of the VCS. The basic computer is an IBM compatible PC with a VGA or SVGA monitor, keyboard, floppy disk drive, hard disk, and interface circuit board. Additional circuit boards are installed to interface the VCS computer with the I/O module and accessories. The hard disk, interface board, and additional circuit boards are described below:

- The hard disk stores the WinVCS Operating System software. The software allows you to program the tests and plot the test profiles. In addition, test results are stored on the hard disk.

- The standard interface circuit card has the COM1 serial interface port and the LPT1 parallel interface port. (you can use COM1 if the mouse is using COM1.) The COM port interfaces with the I/O module's MASTER port. The COM port provides the control and data interface between the VCS computer and the I/O module. (The VCS I/O interface also uses the selected COM port interrupt on the VCS computer's microprocessor chip.) LPT1 interfaces with the optional printer.

- A Digital Signal Processor (DSP) card interfaces the drive and response signal data with the I/O module. The DSP card performs the complex conversions between the computer's signal data and I/O Module's signal data. WinVCS uses the FFT formulas to provide frequency-based data using a fixed Hann window. The DSP card performs the conversions between the external time-based data and the internal frequency-based data. The DSP has two RS-422 serial ports which interface directly with the two RS-422 ports labeled **DSP IN** and **DSP OUT** on the I/O module's rear panel. All the signal data is interfaced through these ports.

7.1.2. I/O Module

WinVCS operates the I/O module to provide the analog and control interface between the VCS computer and the Shaker. The I/O module performs the following functions:

- Converts the digital Drive Profile output from the VCS computer's DSP card into the analog Drive signal. The Drive signal is output to the Shaker.

- Conditions, multiplexes, and digitizes the signal inputs from the Shaker accelerometers. The digitized data is sent to the VCS computer's DSP card.

- Operates the VCS computer from its front panel. Basic test selection, operation and display commands are sent to the VCS computer's COM1 serial port from the front panel switches.

The I/O module interface is divided into two groups:

- The rear panel connections provide the hardware interface.

- The front panel switches and lamps provide the operator interface.

7.1.2.1.   Rear Panel

The I/O module rear panel provides the interface connections and settings for the VCS. Refer to Figure 7-2. The interface connections and switches are described below:

1. **OUTPUT BNC Connectors** — output the drive signal to the Shaker system. Normally, the OUTPUT + connector is used because it outputs the actual drive waveform. The OUTPUT - connector outputs a signal that is exactly 180° out of phase from the drive waveform. The inverted waveform is required on some Shaker systems.

2. **AUX BNC Output Connector** — retransmits internal signals from the I/O module. The AUX connector can be connected to the following internal BNC connectors:

    J12   Conditioned Control Multiplexed inputs. Currently, there is no application for this connection.

    J13   Conditioned Monitor Multiplexed inputs. On I/O modules equipped with the optional Monitor Channel circuitry, the VCS outputs the average of all the monitor channel accelerometer signals through the AUX connector after they pass through the ICP Gain circuits. During automatic operations, these signals will change depending on the level of your test. As an option, you can set the monitor input gain to a fixed gain using The Extended Screen Functions. You can use a fixed gain to retransmit the monitor channel readings to a chart recorder. See Appendix C for more information.

    J14 & J17   OUTPUT + and OUTPUT - drive signal outputs.

    J19   Sine Constant Output. On I/O modules equipped with the optional Monitor Channel circuitry, this connector outputs a full-scale +/- 10 volt signal during Sine operations. The signal represents the position of the of the internal sweep generator. You can use this output as a synchronization signal for strobes, tracking filters, and other external devices.

The I/O Module Circuit Block Diagram on page 7-10 shows the functional location of each connector.
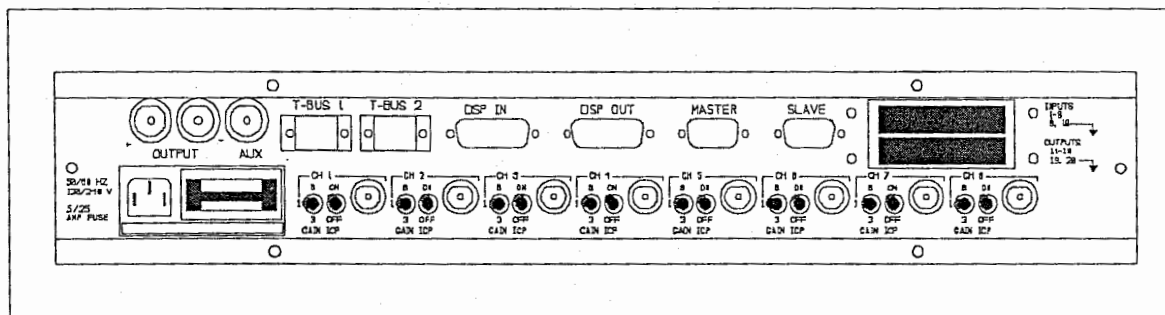
Figure 7-2. I/O Module Rear Panel.

3. **DSP RS-422 Connectors** — used to communicate with the VCS computer's DSP card. The drive and response data is transferred through these connectors. Connector **DSP IN** inputs data from the I/O module and **DSP OUT** outputs data to the I/O module.

4. **MASTER RS-232 Connector** — used to transfer commands and data between the VCS computer's COM1 (or COM2) port and the I/O module.

5. **SLAVE RS-232 Connector** — slave connection for future expansion. At present, a jumper plug must be installed in the connector. The jumper shorts pins 2 and 3 together.

6. **Channel Inputs and Switches** — used to input the accelerometer response signals. Channels 1 through 4 are standard input channels, and channels 5 through 8 are optional. Each set of channels input through amplifier circuits to an Analog-to-Digital (A/D) converter. The converted signal data is sent to the VCS computer's DSP card through the I/O module's DSP OUT connector. The connector and switches are described below.

    a. **INPUT BNC Connector** — used to input the response signal.

    b. **GAIN Switch** — only used in special applications. Always leave the switch set to 1 for normal operations.

    c. **ICP Switch** — enables the internal ICP Gain circuits. Turn the switch ON when an ICP type accelerometer is connected directly to the INPUT connector. The VCS sets the level of current at 4 mA for the accelerometer's signal. Turn the switch OFF when the accelerometer signal goes through a conditioning amplifier before inputting to the VCS. The OFF position disables the internal current drive circuitry. Turn the switch ON at all unused input channels.

7. **Terminal Block TB1** — used for remote operations. Pins 1 through 10 are input pins internally pulled to +5Vdc. Pin 11 provides the Fault output. (Pins 12 through 20 are output pins for future expansion.). Each input pin and pin 11 are ACT (Advanced CMOS and TTL) compatible. Each input can be driven low using an external ACT compatible device (i.e., High = above +3Vdc, Low = below +1Vdc), or by applying a relay contact closure to ground. Pin 11 can drive an external ACT compatible device. The TB1 terminal assignments are listed in Table 7-1.

    Pins 1 through 6 and 11 are defined as follows:

    Pin 1   provides a switched START/STOP TEST input from a remote device. A high-to-low transition (relay closure) starts a test. A low-to-high transition (relay opening) stops the test.

    Pins 2, 3   provides pulsed START and STOP inputs. These inputs are enabled by relay closures from 0.1 to 1.0 second in duration.

Pins 4, 5, 6   The Remote Test Schedule bits select a test schedule defined using the System Manager menu described in Section III. Up to seven test schedules can be selected. Each test schedule runs a series of user defined and selected vibration tests. The test schedule bits are decoded as listed in Table 7-2. The VCS looks at the test schedule bits during a remote START command (TB1 pins 1 or 2) or during the Start Test Schedule command from the System Manager program.

Pin 11   The Fault Output can be used to shut down the Shaker amplifier if a fault occurs during a test. Pin 11 remains high during normal operations. If a fault occurs during a test, pin 11 goes low for two seconds and then goes high again.

| Table 7-1. Terminal Block TB1 Terminal Assignments. ||
Terminal	Name
1	START/STOP TEST (switched)
2	START TEST (Pulse)
3	STOP TEST (Pulse)
4	Remote Test Schedule Bit #1
5	Remote Test Schedule Bit #2
6	Remote Test Schedule Bit #3
7	Not Used
8	Not Used
9	Common
10	Common
11	Fault Output (Two Second Pulse)
12 through 18	Not Used
19	Common
20	Common

| Table 7-2. How to Decode the Remote Test Schedule Bits. ||||
| Remote Bit Signal Levels ||| Test Schedule Selection |
Bit 3	Bit 2	Bit 1	
Low	Low	Low	Run Test Schedule 0
Low	Low	High	Run Test Schedule 1
Low	High	Low	Run Test Schedule 2
Low	High	High	Run Test Schedule 3
High	Low	Low	Run Test Schedule 4
High	Low	High	Run Test Schedule 5
High	High	Low	Run Test Schedule 6
High	High	High	Run Currently Active Test

7.1.2.2.   Front Panel

The Front Panel controls allow you to operate the VCS without the use of a keyboard. Once the system programmer defines the tests, the keyboard can be disconnected. The operators can perform the following functions from the front panel:

- Access all screens

- Define test schedules from the System Manager screen

- Select and operate tests or test schedules

- View the graphic plots of the active test or the stored test files

The front panel controls restrict the operator from most of the programming functions. Only the **Space Bar** selected test parameters can be changed from the front panel.

The front panel switches are described below. Refer to Figure 7-3. Note that each switch is a toggle switch and is activated in the UP position. Each lamp lights when the function is enabled. (The Power lamp lights when power is applied to the I/O module.)
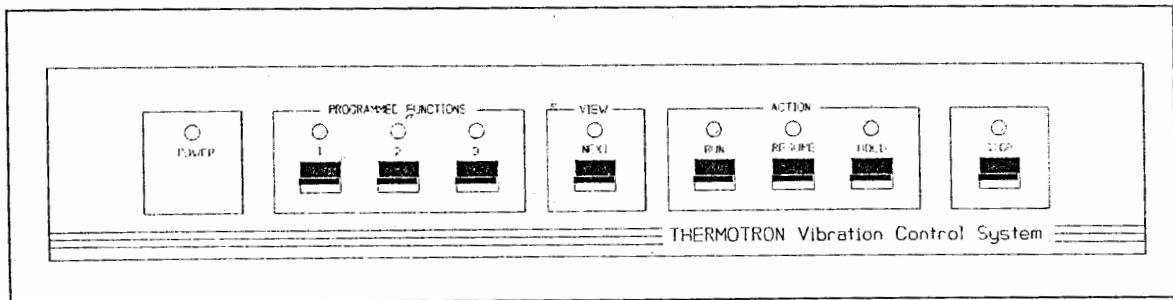
Figure 7-3. I/O Module Front Panel.

1. **NEXT Switch** — allows you to view the graphic plots of the currently active test. These screens are normally displayed using the Random, Shock, or Sine screens:

    a. During a Random test, View displays the following plots:

       - Reference Profile

       - Control Response with limits

       - Drive

       - Dual: Control/Drive

       - Monitor/Control input transmissibility

    b. During a Shock test, View displays the following plots:

       - Acceleration

       - Velocity

       - Displacement

c. During a Sine test, View displays the following plots:

- Acceleration

- Velocity

- Displacement

- Drive

- Dual: Control/Drive

- Monitor/Control Input Transmissibility

3. **ACTION Group Switches and STOP Switch** — control the operation of the VCS.

- **RUN** — starts a new test running from Stop mode or returns a test in Hold mode to Run mode.

- **RESUME** — returns a test in Hold mode to Run mode.

- **HOLD** — suspends updating of equalization. Use the **RUN** switch to take the VCS out of Hold mode.

- **STOP** — ends the test. The current drive data is saved for the Resume function.

7.1.2.3.   Block Diagram

The I/O module circuitry can be divided into three basic circuits. Refer to Figure 7-4.

1. The **Microprocessor Control** circuit controls the internal operations of the I/O module. First, the microprocessor circuits communicate with each control interface:

    *   WinVCS communicates with the I/O module microprocessor through the RS-232 interface.

    *   The remote control terminal block (TB1) inputs the external ACT compatible signals, which are converted into interrupts to the microprocessor. The VCS also outputs its ACT compatible Fault signal through TB1 to shut down the Shaker amplifier.

    *   The front panel interfaces with the microprocessor.

    The Microprocessor Control circuit then operates the I/O module's Input and Output circuits to condition and process the input channel signals and Drive signal.

2. The **Output Drive** circuit converts the data sent by WinVCS into an actual analog signal. The Output Drive circuit operates under control of the Microprocessor Control circuit. The circuit inputs the drive data from the VCS computer's DSP card. Its DAC circuit converts the data to an analog signal and conditions the signal. Its Signal Conditioning circuit outputs two signals that are 180° out-of-phase from each other. These signals provide the OUTPUT + and OUTPUT - drive signals on the rear panel.

3. The **Input Channel** circuit conditions and converts the accelerometer inputs into voltage data. The Input Channel circuit is controlled by the Microprocessor Control circuit. The accelerometer signals are conditioned at the ICP and Gain circuits.

    *   Each ICP circuit is turned ON or OFF by its ICP switch on the rear panel.

    *   Each Gain circuit is automatically set by the VCS.

    The conditioned signals input to the Control Multiplexer. The Control Multiplexer applies the control channel to the Control A/D Converter. The converted data outputs to the VCS computer's DSP card. The DSP card converts the data into the format required by the Control Response Profile.

    If your I/O module has the optional Monitor circuitry, the selected monitor channel signals are conditioned and converted through the Monitor circuitry. The converted data outputs to the VCS computer's DSP card. The DSP card converts the data into the format required by the Monitor Response Profile.

4. The **AUX BNC** connector provides an output connection for the following internal BNC connectors:

    *   J12 — Conditioned Control Multiplexed Inputs

    *   J13 — Conditioned Monitor Multiplexed Inputs

    *   J14 — OUTPUT +

    *   J17 — OUTPUT -

    *   J19 — Full Scale Second D/A Output

    See the *I/O Module Rear Panel Description* on page 7-4 for any output applications of these connections.
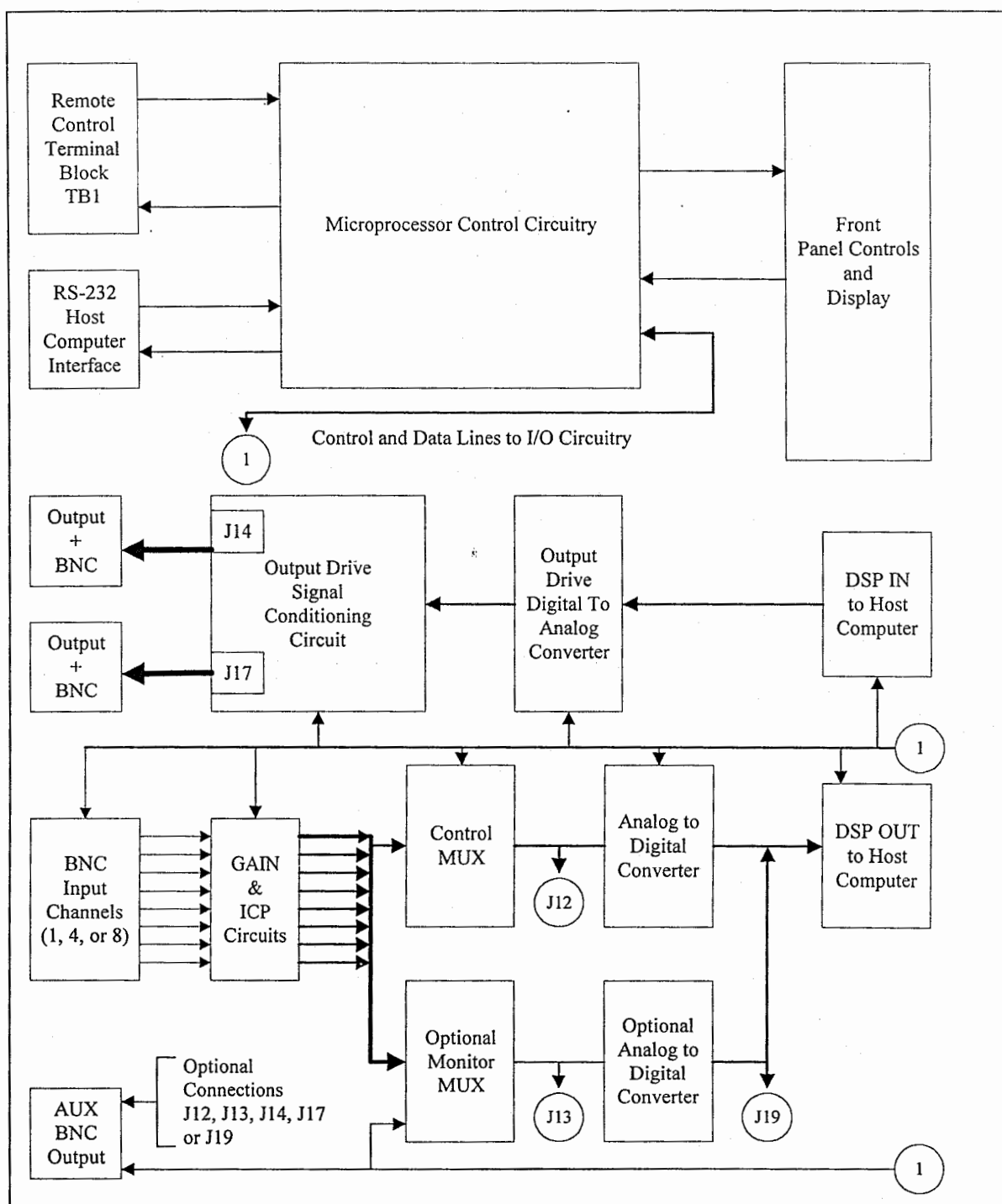

Figure 7-4. I/O module Circuit Block Diagram.

7.2. Installing the Hardware

The following procedure describes how to install the VCS components and cabling. Refer to the Instrumentation drawing located in the Shaker manual's Engineering Drawings.

Tools Needed

- Flathead Screwdriver

- Needle-Nose Pliers

- Cables Provided

- Two RS-422, 15-pin, type "D" cables

- RS-232, 9-pin, "D" type cables

- RS-232, 9-pin, slave terminator (9-pin female "D" with shorted pins 2 and 3).

- 25-pin (male) to 9-pin (female) adapter for a 25-pin COM1 port.

Optional Cables:

- Plotter RS-232 cable

- RS-232 9-pin (male) to 25-pin (female) adapter cable for a 9 pin COM2 port

- Printer cable

7.2.1. Unpacking the VCS

The following paragraphs describe how to unpack, check, and handle the VCS in case of damage.

Carefully remove the components from the shipping containers. Avoid damaging the front panel and rear panel connectors. Accessory kits may be packaged separately. Check the items received against the packing slip. Save all shipping containers and packing material until the system has been inspected and operationally checked.

Inspect all panels for dents, chipped or scratched paint, or other physical damage. Check for bent or broken switches and connectors. Photos of damage are recommended to substantiate claims.

7.2.2. Installation Procedure

Perform the following procedure to install the VCS.

1. Connect the RS-422 cables from the I/O Module **DSP IN** and **DSP OUT** connectors to the VCS Computer DSP card connectors. Refer to Figure 7-5.

    - The cables are polarized so they can only go to the correct connectors.

    - There may be more than two 15-pin connectors on the VCS Computer. Only use the 15-pin connectors on the DSP card.

2. Connect the RS-232 cable between the I/O Module **MASTER** connector and the VCS Computer **COM1** connector. The **COM1** connector can be either a 9-pin or a 25-pin connector. If your VCS Computer has a 25-pin **COM1** connector, use the 25-pin (male) to 9-pin (female) adapter.
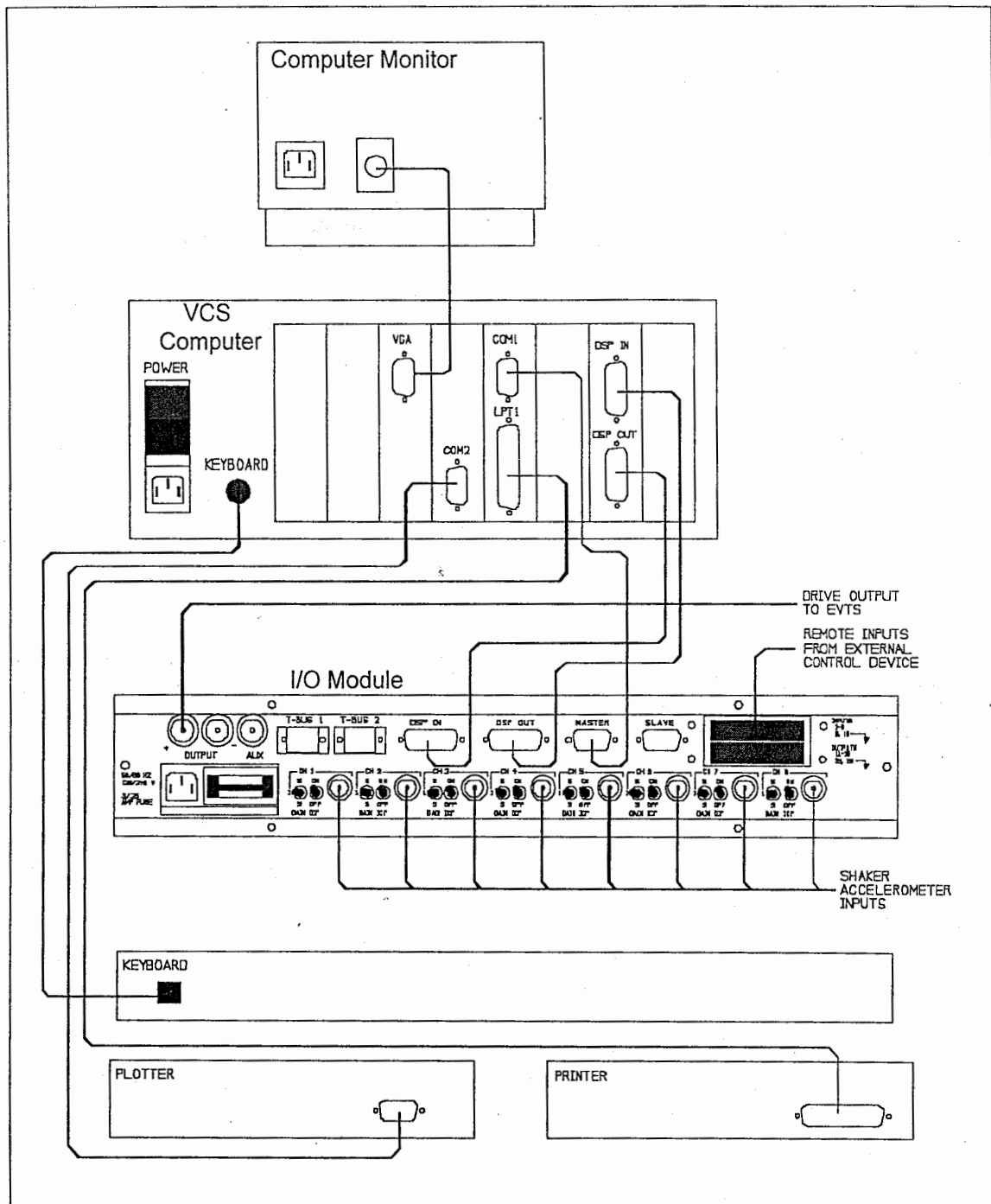
Figure 7-5. VCS Hardware and Interface.

3. Connect the 9-pin slave terminator to the I/O Module SLAVE connector.

4. Connect the coaxial accelerometer cables to the input channel BNC connectors. The I/O Module has one to eight BNC input connectors (CH1 through CH8).

5. Set up each input channel's ICP switch.

   a. Set the **ICP** switch to ON if an ICP accelerometer is directly connected to the input channel. The switch enables the I/O module's Gain circuits to condition the signal.

   b. Set the **ICP** switch to OFF if an externally conditioned accelerometer is connected to the input channel.

   c. Set the **ICP** switch to ON for all unused input channels.

6. If your input channels have a **GAIN** switch, set it to 1. The internal software now determines the proper gain.

7. Connect the coaxial DRIVE cable (normally labeled **PA**) from the Shaker power amplifier to the proper **OUTPUT** connector on the I/O Module.

   a. Refer to the Instrumentation drawing in your Shaker manual.

   b. If your Shaker uses the normal DRIVE signal output, connect the cable to the **OUTPUT + BNC** connector.

   c. If your Shaker requires a DRIVE signal that is 180° out-of -phase from the normal DRIVE signal, connect the cable to the **OUTPUT - BNC** connector.

8. Connect the VCS Computer Keyboard cable to the VCS Computer Keyboard connector.

9. Connect the Video Monitor cable to the VCS Computer Video Monitor connector.

10. Connect the Video Monitor power cable to a 120/240 Vac power source.

11. Perform the following steps to connect a 120 Vac 60 Hz or 240 Vac 50 Hz power source to the VCS **POWER** connector.

    a. Slide the fuse access cover (next to the **POWER** outlet) over. The power legend should read 120 or 240.

    b. If the power legend does not match the power source you are using, perform the following steps.

       (1) Use needle-nose pliers to pull the small board (located below the fuse) out.

       (2) Turn the board around and reinstall it.

       CAUTION: *Use only the 120 volt and 240 volt options.*

       (3) Make sure the voltage on the legend matches the voltage of your power source.

    c. Plug the power cord into the POWER connector.

7.2.3. Optional Connections

1.   To connect a plotter, connect the Thermotron RS-232 cable from the VCS Computer COM2 connector
     to the plotter.

     •   If your COM2 port has a 9-pin connector, use the Thermotron 9-pin (female) to 25-pin (male)
          adapter in addition to the cable.

     •   If your COM2 port is being used, you will need to install an interface card for your plotter.

2.   To connect a printer, connect the Thermotron parallel cable from the VCS Computer LPT1 connector
     to the printer.

3.   To operate the VCS using external control signals, connect the external control lines to terminal block
     TB1 on the I/O module's rear panel. Refer to page 7-4 of this manual.

7.2.4. Installing an Option Upgrade

When you purchase any new options for your VCS, Thermotron sends a 40-pin chip called an electronic
key that allows you to run that option. You must replace the original electronic key that is located inside the
I/O module with the new electronic key before you can use the new options.

CAUTION: The electronic key and the I/O module's electronic circuits contain electrostatic sensitive
                  components. Follow standard electrostatic protection procedures to isolate the electronic
                  components from electrostatic shock.

Perform the following procedure to install the electronic key into the I/O module:

1.   Remove power from the amplifier console.

2.   Locate the I/O module. See Figure 7-6. The I/O module can be mounted inside the amplifier console,
   or it can be mounted under the VCS P/C on a work station.
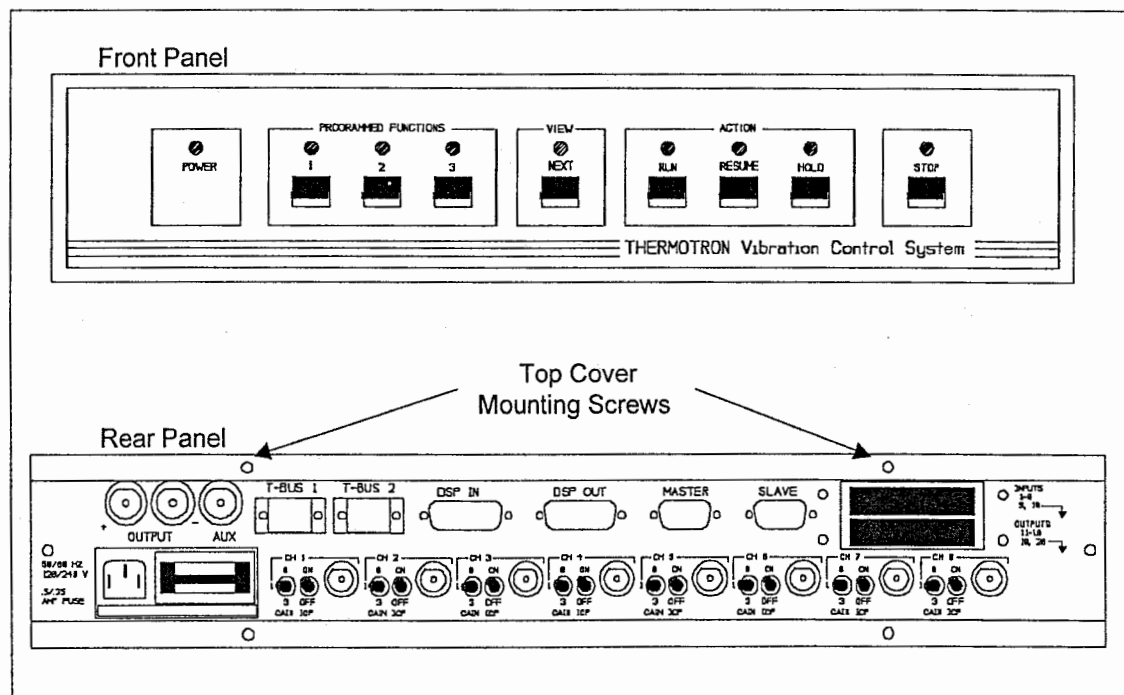
Figure 7-6. I/O Module Front and Rear Panels.

3. Write down all the I/O module's rear panel cable connections. You must disconnect and then re-connect these cables during this procedure.

4. Disconnect all the cables and the power cord from the rear panel.

5. Remove the screws that mount the front panel to the amplifier console or work station, and slide the I/O module out.

6. Place the I/O module on a flat workspace that is protected from electrostatic shock.

7. At the top of the rear panel, remove the two screws that hold the top cover in place, and slide the top cover off the I/O module.

CAUTION: The electronic key and the I/O module's electronic circuits contain electrostatic sensitive components. Follow standard electrostatic protection procedures to isolate the electronic components from electrostatic shock.

8. Locate the electronic key (circuit U17) inside the unit. It is the only 40-pin I.C. chip, and it is socketed for easy removal.

9. Compare the version of the key that you are replacing with the new key:

    •   If the existing key is revision 1, the label on replacement key must be revision 1.1.0 or a higher revision in the form "1.x.y".

    •   If the existing key is revision 2, the label on replacement key must be revision 2.0.0 or a higher revision in the form ".x.y".

10. Note the location of the pin 1 notch on the chip inside the unit. When you replace the chip, the new chip's pin 1 notch must be in the same location for the VCS to operate.

11. Remove the existing electronic key from the unit.

12. Install the new electronic key into the unit, making sure that all 40 pins insert into their sockets and that the pin 1 notch is in the proper location.

13. Connect the proper power to the I/O module:

    •   At the rear panel, slide the fuse access cover (next to the **POWER** outlet) over to read the power legend. The power legend will read 120 (120 Vac) or 240 (240Vac).

    •   Plug the I/O module into a power source that matches the power legend.

14. With power applied, Locate the only LED on the unit's large circuit board. It should be flashing on and off once every second. This indicates that the new key is active.

15. Unplug the unit.

16. Slide the top cover onto the unit, and install the two screws into the rear panel.

17. Mount the unit into its location on the amplifier console or workstation.

18. Install all the cables that you removed in step 4 into their rear panel connectors.

19. Apply power to the amplifier console.

7.3. Calling Thermotron for Assistance

At Thermotron, our telephone staff is trained to match your current needs to the proper person or department. To accomplish this, they need the following information:

- Your name

- Name of your company

- Model and serial number of the (chamber, shaker, etc.)

- Brief description of the problem, question, or request

Once you obtain this information, contact the Parts and Logistics Department at Thermotron Industries in Holland, Michigan. Telephone (616) 392-6550 between 7:30 a.m. and 5:30 p.m. Eastern Standard (Daylight) Time. The telephone staff person who takes your call will use the above information to determine where to direct your call or how to assist you.

7.4. Returning Materials

7.4.1. What to do if a Thermotron Instrument Fails

1. Contact your local Thermotron Field Service office. A service representative will help you determine the nature of the problem and the proper steps to resolving the problem.

2. To return a part or Thermotron instrument, follow these steps:

    a. Contact the Parts and Logistics department at Thermotron Industries in Holland, Michigan, USA. The telephone number is (616) 392-6550, and the Fax number is (616) 393-4549. The hours of operation are 7:30 a.m. to 5:30 p.m. Eastern Standard (Daylight) Time (ES(D)T).

    b. When you telephone, our staff needs the following information: your name, the name of your company, the model and serial number of your [chamber], and a brief description of the failure.

    c. Parts and Logistics will authorize return of the material and issue a Returned Material Tag (RMT) number.

    d. Write the name and telephone number of a contact person at your location and the RMT number on the packing list.

    e. Write the RMT number on the outside of the shipping container in a visible location.

    f. Ship all parts FOB (Free-On-Board) to:

                        Thermotron Industries
                        836 Brooks Avenue
                        Holland, MI 49423
                        ATTN: (Issued RMT Number)

    NOTE: *Thermotron will replace a part under the terms of the warranty at no charge if the defective part is received within 30 days of the issuance of the RMT number. If the part is received after 30 days, Thermotron will invoice the customer for the full cost of the replacement part.*

7.4.2. What to do if a Non-Thermotron Instrument Fails

1. Contact the original equipment manufacturer according to the instructions in the OEM instrument manual. Follow the manufacturer's procedure for replacing the failed instrument.

2. To contract Thermotron to install the instrument at the prevailing rates, contact your local Thermotron Field Service office.

Appendix A
Vibration Mode Features and Capabilities

A. Overview

This Appendix details the features and capabilities of WinVCS for the Random, Sine, and Shock modes.

A.1. Random Mode

Data Acquisition

Control A/D:	1 input, multiplexed from up to 8 input channels.
Monitor A/D:	1 input, multiplexed from the up to 8 input channels.
Resolution:	The 16 bit A/D converter provides 1/64k resolution.
Sample Frequency:	2.56 times the max frequency.
Max Frequency:	User programmable, up to 4500 Hz max.
Analysis Resolution:	100, 200, 400, or 800 lines.

Maximum grms Level

Limited to the following formula:
6825 > (grms Level)(mV/g)
where (grms Level) is the Random Profile rms level and (mV/g) is the sensitivity of the accelerometer(s).

Monitor Output

Monitor A/D:	Multiplexed output from the 8 inputs.
Voltage:	20 V peak-to-peak maximum.
Current:	20 mA maximum current.

Reference Spectrum

Up to 120 breakpoints per profile.
Up to 120 breakpoints for tolerance and abort lines.
rms over/under – programmable independently.

Level Scheduling

Up to 60 levels per profile.
Time programmable at each level.

Data Storage

Automatic Graph Storage during Stop or Abort operations.
Manual Graph Storage from the Graphic Screens.
Manual Drive storage at User Command (MODEL).
Automatic Drive Storage.

Test Duration

Programmable, 1 second to approximately 42,000 hours.

System Protection   Open loop detection at the beginning of each test.
                                               Over/Under rms detection during each test.
                                               Over/Under Lines Past Abort Level detection during a test.

A.2. Sine Mode

Data Acquisition

Control A/D: 1 input, multiplexed from up to 8 input channels.

Monitor A/D: 1 input, multiplexed from the up to 8 input channels.

Resolution: The 16-bit A/D converter provides 1/64k resolution.

Sample Frequency: 2.56 times the max frequency.

Max Frequency: User programmable, up to 4500 Hz max.

Analysis Resolution: 100, 200, 400, or 800 lines.

Display   Demand and response are shown.
                                Selectable acceleration, velocity, or displacement.

Frequency

Frequency range: 1Hz - 4kHz

Frequency resolution: Crystal controlled to .01%

Control Characteristics

Acceleration: 0.02 g to 100 gpk

Velocity: 0.01 in/s to 100 in/s

Displacement: .01 in to 4 in p-p

Control Response: 1 to 8 channels may be used in any combination for single
                                point or average control.

Monitor Response: With optional second A/D, any of 1 to 8 channels may be
                                selected and displayed in real time without going into fixed
                                drive. Monitor Channel tolerance and abort limits are
                                independent of control limits.

Test Definition

Demand: Up to 120 break points in terms of acceleration, velocity, and
                                displacement per test.

Tolerance and Abort: Up to 120 segments for tolerance and abort limits.

rms Abort: Independently programmable over and under grms.

Stored Tests: Number of tests limited only by the size of the hard disk.

Sweep Characteristics

Direction:	Up, Down, or bi-directional.
Type:	Linear or logarithmic.
Rate:	Logarithmic Octave – 0 to 99 oct/min.
	Logarithmic Decade – 0 to 99 dec/min.
	Linear – 0.01 to 5,000 Hz/min.
Number of sweeps:	0 to 9999 or continuous.

Data Storage: Automatic Graph Storage at Stop or Abort.
Manual Graph Storage from Graphic Screens.
Test program storage during the Define function.

Number of Data Records: Only limited by the size of the hard drive.

Level Scheduling: Up to 60 levels per profile.
Time Duration or Number of Cycles are programmable at each level.

System Protection: Open loop detection at the beginning of each test.
Over/Under peak voltage detection during each test.

A.3. Shock Mode

Data Acquisition

Control A/D:	One
Resolution:	16 bit A/D converter.
Display:	Demand and response are shown.
	Selectable acceleration, velocity, or displacement.

Reference Profile

Pulse Type:	Half Sine
	Terminal Peak Sawtooth
	Initial Peak Sawtooth
	Triangle
	Rectangle
Pulse Duration:	1 to 2000 mS
Pulse Direction:	Selectable Positive or Negative

Test Result Storage   Saved to user-defined file location.
Limited only by the size of the hard disk drive.

Test Reference Storage   Number of profiles limited only by size of hard disk.

Level Scheduling   Up to 60 levels per profile.
Number of pulses programmable at each level.

Data Storage   Automatic Graph Storage at Stop or Abort.
                                     Manual Graph Storage from Graphic Screens.
                                     Manual Drive storage at User Command (MODEL).
                                     Automatic Drive Storage.
                                     Program is saved during Define function.

Test Duration   Programmable, number of pulses

System Protection   Open loop detection at the beginning of each test.
                                     Over/Under abort detection during each test.

Appendix B
List of Acronyms

The following list provides the full name of the acronyms commonly used in this manual.

A	Amperes
ACT	Advanced CMOS and TTL compatible device
A/D	Analog-to-Digital
COM 1	Computer's Serial Communication Port 1
CMOS	Complimentary Metal Oxide Semiconductor
DSP	Digital Signal Processor
EVTS	Electrodynamic Vibration Testing System (shaker system)
g	Gravity as a measure of acceleration
g^2/Hz	units of gravity squared divided by the signal bandwidth – the mathematical expression of Power Spectral Density
Hz	Hertz
ICP	Refers to the ICP type accelerometers
in	Inches as a measure of displacement
ips	Inches per second as a measure of velocity
LPT1	Computer's Parallel Port 1
mS	Milliseconds
MUX	Multiplexer
mV/g	Millivolts per unit of gravity – used to measure accelerometer response signals
pk	Peak
p-p or **pk-pk**	Peak-to-peak
PSD	Power Spectral Density
rms	Root-mean-square
TTL	Transistor-Transistor Logic
V	Volts
VCS	Vibration Control System
WebVCS	WinVCS web server
WinVCS	Vibration Control System for Windows Software Application

Appendix C
Common Terms and Definitions

C. Overview

The following paragraphs provide definitions and descriptions of terms and definitions used for vibration testing.

C.1. Common Terms

The following terms are used to describe functions of vibration testing. Some of the definitions listed below are followed by examples that help apply them to their vibration testing usage. The examples are indicated by bullet marks.

Acceleration
The rate of change of velocity with respect to time, usually along a specified axis, often measured in G's (gravitational units).

- As a shaker moves from peak-to-peak, it theoretically stops during the instant it changes direction. The shaker armature must accelerate from stop to maximum velocity to maintain the frequency (or power spectral density in random testing) and displacement induced by the drive signal and field coils.

Amplitude
The magnitude of variation (in a changing quantity) from its zero value. Amplitude is modified with an adjective such as peak, RMS, average, etc.

- The amplitude of the drive signal current or frequency is increased to apply more force to the shaker. As the force is increased, the acceleration amplitude at the armature increases.

Breakpoint
A programmed change of amplitude during random testing.

Displacement
The change in position from lowest to highest points.

- If the armature moves 0.4 inches up from center and 0.4 inches down from center, its displacement is 0.8 inches peak-to-peak.

Force
The energy applied to the shaker to move the armature, fixturing and product. Force is found by using the following formula:

Force = Mass x Acceleration

- On a shaker, the mass of the shaker load is the total moving weight of the armature, fixturing and product.

Frequency
The number of occurrences per period of time, normally expressed in Hertz (Hz) or Cycles per Second (CPS).

- In sine testing, the drive signal outputs one specific frequency. In random testing, the drive signal outputs multiple frequencies within a specified bandwidth.

Harmonic   A sinusoidal quantity that is an integral multiple of some fundamental frequency (1X).

- Example: 1X=100 Hz; 2X = 200 Hz; 3X = 300 Hz; etc.

Isolation   A reduction in the severity of transmitted motion usually attained by proper use of a resilient support.

- The shaker air isolation system air bags isolate the shaker vibration from the floor.

Octave   The interval between two frequencies, differing by a ratio of 2:1. The upper octaves of 100 Hz are 200 Hz, 400 Hz, 800 Hz, etc.

PSD   Power Spectral Density, the term used to describe the intensity of Random vibration. PSD is measured in mean-square acceleration per bandwith of frequency spectrum (g2/Hz).

Random Vibration Vibration of instantaneous magnitudes over some bandwidth where there are no periodic or deterministic components.

Resonance   The frequency at which a constant force input results in maximum response.

- During vibration testing, the acceleration of the product jumps up dramatically at its resonant frequency.

Sine Vibration   Vibration of one single frequency, typically measured in Hertz (Hz) or Cycles per Second (CPS).

Shock Vibration   Application of a single acceleration waveform in the form of a pulse. A shock waveform is typically measured in peak gravity level (g's peak).

Transducer   A device that converts mechanical energy into an electrical signal, such as an accelerometer.

Transmissibility Ratio of response motion to input motion.

- The shaker armature has high transmissibility. A shaker's air isolation bags have a very low transmissibility.

Velocity   The rate of change of displacement per unit of time, often in inches per second.

- If a shaker can experience a 1" displacement at 12 Hz, the shaker's velocity is [V= $\pi(12)(1)$] about 37 inches per second

C.2. Special Definitions

The following definitions describe important terms and devices in greater detail.

C.2.1. Accelerometers

The accelerometer is the device we use to sense motion through the armature, and sometimes on the product. An accelerometer consists of a cross-section of quartz crystal, suspended in a special mount. The mount's design takes advantage of a special property of the quartz crystal - the Piezoelectric Effect. The Piezoelectric Effect is the ability of quartz crystals to output a small electrical voltage when they are stressed, compressed or strained.

Each accelerometer must be accurately gauged and certified to output so many microvolts, or picocoulombs per g of acceleration (pc).

Two types of accelerometers are commonly used today: the charge type and ICP type accelerometers. The charge type accelerometers directly output the Picocoulombs sensed at the quartz crystals. The ICP type accelerometers have a built-in electronic amplifier. The amplifier boosts the quartz signal into the millivolts per units of gravity range. The amplified signal gives the reading a greater signal-to-noise ratio.

ICP Accelerometers output voltages differently in sine and random testing. During sine testing, accelerometers output in millivolts peak. In random testing, the same accelerometers output in millivolts rms. This becomes important when using test equipment to measure the outputs of the accelerometers. Digital multimeters read in true rms, while oscilloscopes can read in peak voltage. When making sine measurements, use the following formulas to convert between peak and rms.

$$rms \times 1.414 = Peak$$

$$Peak \times .707 = rms$$

C.2.2. Random Testing

Random vibration testing applies multiple frequencies of various amplitudes to the shaker at the same time. These frequencies are applied through a specified bandwidth, such as 5Hz to 2000Hz. Random can be compared to one laying one's arm across a piano's keyboard, an orchestra tuning its instruments, or the vibration transmitted by a jet engine.

Random vibration is measured in Power Spectral Density (PSD). PSD refers to the envelope of energy contained within the random test spectrum. Individual components constantly change frequency and amplitude in a random spectrum. For this reason, the area of power, rather than each frequency, is measured.

For the purposes of calculating force and adjusting instruments, all measurements are calculated in rms.

C.2.3. Sine Testing

Sine testing applies one frequency at a time to the shaker. Audibly, sine can be compared to a single note as played on a piano, or the whine of a jet engine. Sine is used less for vibration testing than for maintenance and calibration. Sine is easier to read than Random, and is preferred when testing for resonant frequencies and calibrating instruments.

During Acceleration Response Testing, we can determine if the resonant frequency of a product lies within the frequency of a test spectrum. In addition, this test can be used to prove structural integrity. The resonance of a structure should never change under normal conditions.

For the purposes of calculations and instrumentation adjustment, all sine measurements are scaled in peak voltage.

C.2.4. Shock Testing

Shock testing applies a single acceleration waveform to the shaker in the form of a shock pulse. At the shaker, the shock pulse is characterized by sudden and larger displacements that develop significant internal forces in the product. The shock pulses are used to test components that may be subject to sudden impacts in their real-world environments. A shock pulse is normally measured in its peak gravity level (g's peak).

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